1983 NASA AUTHORIZATION

(And NOAA Landsat Authorization for 1983)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

OF THE

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FIELD HEARINGS

FRIDAY, FEBRUARY 5, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Kennedy Space Center, Cape Canaveral, Fla.

Mr. FLIPPO. Since this is a formal hearing, I will start by calling the meeting to order. This is the first hearing on NASA's fiscal year 1983 budget. As you know, NASA's budget request for fiscal year 1983 has not been released yet. We'll probably attend the briefing on the fiscal year 1983 budget request on Saturday of this week. But we wanted to come down and talk with you and your fine staff. We look forward to the briefing. We probably will interrupt you with a question or two if that's acceptable. Before we get started, let me congratulate you and your people for the progress you have made with two successful launches and rapid progress toward the third.

Mr. SMITH. Thank you, sir.

Mr. FLIPPO. Please begin.

Mr. SMITH. Thank you, Mr. Chairman. I would like to take this opportunity to welcome you and your staff to KSC this morning. In the interest of saving time, I would like to submit for the record a prepared statement on activities at KSC since the subcommittee's visit last year. In summary, I would like to give you a brief overview of our present status at KSC and the future activities that are planned. The first presentation to the subcommittee will be by Dr. Gray. He is going to give you the planning for STS–3 through STS–8 processing. He will be followed by Tom Utsman, who is heading up our preprocurement activities. He will brief you on the planning and implementation of self-sufficient contractors. Finally, Pete Minderman will review our Shuttle facilities and the status of them. I also asked George Page, who is our launch director, and Joe Malaga, who is our comptroller, to attend these hearings. I believe with these key people we should be able to answer any questions you may have. If not, we know where to get the answers, so please feel free to interrupt us.

Mr. FLIPPO. You do, of course, know everyone present from the subcommittee?

Mr. SMITH. Yes, I know all the people. We've had to answer their questions may times in the past.

Congressman, you've picked a historical day for your hearing. This afternoon is the Spacelab Turnover Ceremony—a celebration with international flavor to accept the first Spacelab flight unit.

Vice President George Bush will attend the ceremony. It's going to be a busy day and hopefully a very successful one for us.

I'm not going to spend much time talking about our organization (fig. 1). Of course, George Page is head of the Shuttle operations; Pete Minderman is head of design engineering—all our facility design work is done there. Tom Utsman is head of technical support. I have also asked him to be chairman of our procurement development working group. Joe Malaga is the comptroller. We haven't made any significant changes since your last visit. We do have under consideration, however, some reasonably significant changes in our organization. We feel that we are at the threshold of a transition to the operational era as the Shuttle system starts to mature. Therefore, we do have some organizational changes under active consideration. I hope to announce those changes in the next couple of months. And that's going to be a signal not only to our people, but also to our contractors that we're at a point where we've got to change the way we do business. We must be making the transition from development of the Shuttle to operation of the Shuttle—something that we've never dealt with before.

We're going to be very busy this year with expendable launches (fig. 2). We have 10 expendable launches scheduled using 3 Atlas-Centaur and 7 Delta vehicles. Of course, besides that, we have three Shuttle launches planned for this year. The fifth launch, scheduled for November, is the first "operational" flight with the first paying customers. The fourth flight, scheduled for July, will fly the first DOD payload; it is a classified payload and that's going to create a few security problems for us, but we think it will be a very good pathfinder. Although it is classified, there will be others in the future that are much more sensitive than this particular payload.

The first DOD payload is going to create a unique situation for us in that the Air Force facilities across the river are not ready to process payloads for integration into the Shuttle. As a workaround, we will integrate the payload in the vertical processing facility. This is the only classified payload that is planned to be processed at that facility because we'll have foreign nationals and other types of payloads using that facility. So that's not the place to mix classified and unclassified payloads.

The only type of security we're going to have on the first DOD payload flow is one of visual security, not data security. So we can handle that without any trouble. But in the future we've got to increase our level of security to meet the requirements of the DOD.

I would like to give you an overview of the planning and implementation of self-sufficient contractors this year. Mr. Utsman will go through a more detailed briefing. We are preparing to go out with an RFP for a base operations contract in the March–April timeframe, with a selection in the latter part of the year and bringing contractor onboard the beginning of fiscal year 1983 (fig. 3). Parallel to that, we are working on a selection process for a Shuttle processing contractor. We have targeted the release of that RFP to occur after the base operation contractor has been selected. We are convinced that there are some services that the Shuttle processing contractor may want to procure from the base operations contractor. We are trying to scope the work of the SPC so that all the tools

that the contractor needs to do his day-to-day job are his responsibility. Today KSC furnishes much of the support a contractor needs. For example, if Rockwell needs a crane to lift something then the crane and the operators are furnished by a support contractor. That creates a lot of interfaces, a lot of scheduling interfaces, which work well, but we think there are some efficiencies to be gained by making the contractor responsible for it. And, even more importantly, it puts us in a posture where we can hold that contractor accountable for his performance. We can measure his progress since he is not influenced by factors outside his control. Also, we think we've come up with a much better motivational scheme for the contractor with an incentive contract arrangement. We think it's a great way to go.

You asked me in my office about the cargo processing contract. We show it downstream somewhere after we've processed a number of cargos and found out what that job is. Today we do not see it starting before the later part of next year, if at that time.

When we started planning the Shuttle processing contract, we've been studying that as you know for some years, we had planned on bringing a contractor on board when we're in the 8th, 9th, 10th flight range, maybe even out here in the 25th flight range, with an RFP perhaps going out about a year later. We started looking at that original concept after STS-1 since it was so successful. That success allowed us to start thinking more aggressively; and we came to the conclusion that while there are still some developmental problems with the Shuttle vehicle, with very heavy involvement by the development contractor and the Government development team, the launch rate is low, and fewer vehicles are in flow here at KSC. That, we concluded, is the easier time to make a transition from the present contract arrangement to the new one. The big question in the mind of potential bidders was could they complete against Rockwell? We have always felt that competition was possible. But that was a big question in the minds of many contractors.

We presented this plan to accelerate the Shuttle processing contract to Mr. Beggs. We got his concurrence, and we have moved out. First, we felt that we had to understand the concern of the contractors. Also, they've got to understand the concerns and either prove that they are real or not real. So, we came up with an approach of inviting potential bidders to observe the processing of STS-3, starting with the orbiter going into the orbiter processing facility continuing until it comes back to the OPF. This will allow them to assess that whole process. They're not just assessing the Rockwell job, they're assessing the total processing job. And if you look at the element contractors—Rockwell, Martin and USBI—they are only about 60 percent of the total manpower for the job that we've going to put into SPC. Initially we had two planning sessions with several companies helping us lay out a plan. I'd say at the end of the first session the result was on the negative side—the companies were very skeptical as to whether an assessment could be done and whether it would be meaningful. We got them back in about 2 weeks and at that time they'd shifted from negative to at least neutral and perhaps on the positive side. And as a result there were eight companies that we selected that wanted to participate in the

assessment. It's all the incumbents, and Grumman, Lockheed, General Dynamics, and United Airlines.

General Dynamics has dropped out for some corporate resource reasons, but we still have the others in the fold. We will be looking at the results of their assessment, which is a very key point to us, in determining if we continue or if we modify our planning for SPC. We'll be trying to get those results a few weeks after the return of the orbiter to the OPF. Personally, I am very optimistic that this is still a good way to go and that we'll save the Government money. We estimated, in a very conservative way, at least a 20-percent savings over the way we're doing buisness now. And I think that's a conservative estimate. Part of the whole process is the Government changing the way we do business with our contractors. Today we are very heavily involved in their planning, procedures, and approval cycles. We felt that we have to change that and allow them more leeway and authority to do their job. The Government will operate in more of a surveillance mode than we do now.

So we're faced this year with a challenge of changing the way we do business with our contractors and encouraging more competition for SPC. So this Center faces one of the most challenging years as we begin the transition to the operational era.

Obviously, when we start changing the way Government employees do business, we're not met with enthusiasm by all people. Also, there are concerns about reorganization; they are causing some perturbation in our morale.

Mr. FLIPPO. Tell me about the morale here now.

Mr. SMITH. I think the morale and the enthusiasm toward getting the Shuttle launched are still quite good, and I'm not concerned with that. I think we've got several things that affect the Government employees morale today. "Are we withdrawing? Am I losing my job because of changing the way I interface with the contractor?" That's a concern. We say we're going to do some reorganization. That's a perturbation on the morale. Those alone would be hard enough to handle, but one that's worrying us on top of that is, frankly, the Civil Service Reform Act. We went through this first year of the so-called merit pay whereby the supervisors and managers would not be eligible for the in-grade longevity step increases; they would be awarded for quality performance. This year's dissatisfaction was caused primarily by the 11th-hour changes ordered by the Comptroler General and the Office of Personnel Management's transition year guidelines which drastically decreased the amount of money in the merit pay pool. The end result is that between 10 and 20 percent of our employees under merit pay are receving less salary than the employees who are not under merit pay. We have, for example, one employee—who was rated outstanding—who this year will get $285 less than another GS–15 not in merit pay. And that, very honestly, has had a very major effect on attitudes of all our managers.

Mr. FLIPPO. Is that a short-term situation?

Mr. SMITH. No; I don't think it's a short-term situation. The theory behind that whole reform act was to be able to award those outstanding and highly successful performers at a greater rate than the others, and it just hasn't turned out that way. It really

has turned, I think, all of management pretty sour on merit pay. And that's a big contribution to the moral problem. Also, I think there is a additional morale problem with the Senior Executive Service, with the restrictions on the bonus system that occurred, although the increase in the paycap has helped somewhat. With merit pay as it is today, you to through a lot of redtape with very little results. It's a bad thing. So, in my opinion, the Civil Service Reform Act is a major contributor to tne decrease in morale.

Like I said, we're in a major transition period at ths Center and face one of our most challenging years.

Dr. Gray is the next presenter.

Dr. GRAY. Mr. Chairman and staff members, it's a pleasure to be able to talk to you today about what we've done, about what we're planning to do in next several years, and what our outlook is for the launch, launch rates, and our capabilities here. May I have the first chart (fig. 4)?

These are the three principal subjects I'm going to talk about. I'm going to talk just briefly about what we're using for priorities in our planning and moving on in the future and tell you about our outlook for launches 3 through 8, and then a forecast beyond that as to what we think our capabilities are, and tell you what we thik we can do in the out years.

Just quickly I'll tell you what we are listing as our priorities at the Center (fig. 5). This one, of course, is all-important; safe and successful launch operations. That is the first thing we show on our list of priorities. We're very concerned with, and are spending a lot of effort trying to find out what and where we are spending our money on operations and what we can do to reduce those costs. Dick just talked about one of the efforts, our contracting modes, which we think will result in lower costs. We have very active efforts underway now and plan to have in the next few years to try to get those costs down to the lowest level we think is feasible. We want to maintain launch schedules. One of the other things you'll hear more about today, is that, of course, it's important not only that we launch, but that we build the facility (the Spaceport) and the launch site to the capability that we have to in order to make it a viable long term launch site with the capability to do the missions of the future. That's very important. Turnaround efficiency is coupled with the launch schedule. We are very active also helping with the Vandenberg activities in support of the Air Force.

Let's take just a quick look at what we are planning on (fig. 6). Right now the program plans call for 32 flights through 1985. Twenty-four flights per year is the launch rate total with the KSC launch rate (18 per year) on the bottom line. So you can see 1, 3, 5, and 10 in 1984, getting up to a maximum of 15 in 1986 and 1987. This 24 is the total max rate now planned in the program at this stage of the game, with six at Vandenberg during that period. We plan on four orbiters. These are the delivery dates of the next three and the first operational flight that Dick mentioned in November of 1982. Let me talk briefly about what facilities we're bringing on line to do this (fig. 7). Of course, we do have what we call our first line of facilities—first pad, first mobile launcher, and so on. It will require additional facilities to approach the launch rate we want. This is what we're planning to bring on board—the

second bay of the OPF will be ready in June when the second orbiter gets here and the second mobile launcher will be ready in September of this year. Firing room 3, an additional firing room, is principally being brought on line for additional firing room capability, as well as for secured classified missions. This will be our classified firing room from which we'll operate the classified missions. That facility will be on line in December. Additional high bays (the other two high bays in the VAB) will be on line in June of 1983. What we call our software production facility (this is an offline facility where we can build software for the operations without having to do it in the firing room) will be on line in October. A solid rocket motor processing facility will be ready in January of 1984 and Pete will talk a little more about that later. As to the third mobile launcher platform, we're planning to try to bring that on line so that it's available for use in September of 1986, as well as Pad B. Pete will talk to you more about those facility projects.

Mr. FLIPPO. Which of those are new starts?

Dr. GRAY. The SRM Processing Facility is the only new start. These other ones have been in the program all along.

Mr. SMITH. We want to be sure that we don't get constrained by facilities as we learn to operate this vehicle—that if we have the capability to up that launch rate, assuming we've got solid motors and external tanks and so forth, we are not constrained by facilities limitations.

Dr. GRAY. I plan to show to you some data later which will explain why that's very important and very critical to the program because of the mobile launchers.

Mr. SMITH. And very critical to the cost per flight.

Dr. GRAY. It turns out that they are in the critical path. And in fact, with three orbiters and two mobile launchers, we'll have orbiters sitting around 50 percent of the time with no place to put them. So, I'll show you some data later that shows why that's needed.

Now I'm going to talk about 3 through 8 (fig. 8) and I'll go through that just about as fast as you want, but will talk about what is planned for each of them starting with STS-3. Then I'll give you a summary of our hoped-for progress will be in terms of stay time in the various facilities and the checkout times involved.

For STS-3—these were some of the basic elements associated with this particular mission, the one we're underway with right now (fig. 9). The OMS pods were not removed. We do have a cryo tanking test planned for checkout of the tank insulation. There is another dry countdown required. The reason these things are interesting on STS-3 is because they are things that we do not plan to do later. They do take some time in this flow and these are things that will not be required or be accomplished on later missions. We are, in pretty near all cases in these schedules, working a 6-day week on three shifts per day, with some activities, in fact, on a 7-day week. All of our mod work and some other critical path work runs on a 7-day, 3-shift basis. Now that doesn't mean everybody works that, of course, and in some cases the external tank and solid boosters don't, but all of our critical patn activity is on a 6-day week and in some cases seven. So, we've got a pretty active work schedule.

These are some of the principal dates associated with STS–3 (fig. 10). It was flown back here on November the 26th. We started the SRB stacking on the date which you can see here. The ET has been here since October. It was mated the first of the year, right after the holidays. The orbiter rolled out of the OPF, as you're probably aware, just 2 days ago. We plan to roll out of the VAB on about the 19th. That is the present planned date. That looks pretty good. The date we're targeting for launch for STS–3 is the 22d of March. This mission lands back at DFRC after it completes its 7-day mission and after it is turned around and flown back here, it will show up on the 9th of April for turnaround again. Now I'm going to show you the processing time for each of these facilities, and I'll give you a summary later as to how we're progressing on the days. On STA–3, 53 work days in the OPF, 15 days in the VAB, and 20 days on the pad is what we're projecting. This turned out to be about right for the OPF, and this is what we're planning for the pad and the VAB.

Mr. FLIPPO. How many days does it cost you by not landing here?

Dr. GRAY. About 11, 11 to 12. Maybe even a little more. It takes about 11 days at DFRC to do all the deservicing and preparing to bring it back and about a day's ferry flight. So, it's on the order of 12 days.

Mr. FLIPPO. What additional facilities would you need here to bring the orbiter back here?

Dr. GRAY. We don't need anything here, Mr. Chairman. The reason we're landing at DFRC right now is mainly because of the long runways at Edwards Air Force Base and the total capability to land with essentially unlimited runway space, cross wind runway landings and this sort of thing. So it's really just our preference until we get enough landing experience to know the full operating characteristics. They'd just as soon not attempt to use our runway which has limited length, though it's quite long. In all the landings to date, the crew said there is no problem with landing on a runway. Their rollout distances have been about 8,000 feet or less. They've always landed within 3,000 feet of the threshold, so they could have landed on our runway without any difficulty. Now the only other thing they're trying to do is get some crosswind data because we have crosswinds here very often. Some of the missions are purposely trying to pick landing azimuths that will give them substantial crosswinds so they can check the handling for crosswind landings. That's one of the primary things they still want to do and go to a full auto land, which has not happened. Now once they meet those objectives, they will be landing here.

A couple of more things on STS–3—it did take a little longer than is planned for some of the subsequent flights. As you'll see (figure 11), we did have a lot of mod work to be done because on these vehicles we're still making a considerable number of changes to get to the operational capability we need. There were 94 mods that had to be done for STS–3, which were fewer than for STS–2, but still substantial. These are the thermal protection tiles—about 475. That compares to 1,500 that were taken off and replaced on STS–2. We think that number, from the data we have so far, will be substantially less than this on each flight, on the order of a couple of hundred. The fuel cells were removed and replaced be-

cause of the on-orbit problem. We added a fourth fuel cell cryo tank set as part of one of these mods, and replaced the No. 1 APU. These were the principal things that we've done. We installed a different payload on this flight, the OSS payload. This is the first flight for a Getaway Special and both those payloads are presently installed.

Mr. IRONS. Do you have any details about the Getaway Special, which one it is and where it came from?

Mr. PAGE. It's really just a prototype of the Getaway Special canister. It does have some instrumentation on it.

Mr. IRONS. But it's nobody's Getaway Special you're taking?

Mr. PAGE. There are no specific experiments on it.

Dr. GRAY. It's just a verification canister with some environmental measuring equipment in it.

These are some of the things that are already complete on STS-3 (figure 12). The postflight troubleshooting is always a very important thing, especially in these early missions. Every little data anomaly of any consequence is seen in flight. Of course, the very first thing we do want to do is troubleshoot where we can maintain the configuration so we can determine the source of trouble. We think these times hopefully will go down because we may have fewer things to investigate each time. The payload from the STS-2 flight was taken out in December. We went through our mod periods. We installed the OSS payload January 10, ran an interface test on the 26th, and a test with the Houston control center on the 27th. TPS waterproofing was done during this period of time, with rollout February 3. These are the principal things (figure 13) yet to be done, and this is underway right now. The orbiter ET umbilical mate occurred in the VAB. With the orbiter mated to the tank, these tests are in work. This will be the overall all-up systems interface test once all the connections are made to make sure that the entire system works together. Transfer-to-the-pad preps are shown here and go-to-the-pad will occur on the 19th. Incidentally, the VAB and pad activities are pretty much the same as what we've been doing, and these are pretty constant throughout. Some of these tests will be modified as we go on, but these are the principal things. You see here the dry countdown demonstration, which consumes about 2 days. That's the cryo load test we talked about. These are the standard hypergol loading and countdown preps, with the launch targeted for March 22. These kinds of charts (fig. 14) for each of these flows will be in the handout if you need to go over them, but it does show the principal things that we've been discussing. The engine checkouts and tests are shown. There is a lot of engine activity required on each of these flows. It shows where the payload was installed. It shows the 10-week period in the OPF and the 2 weeks in the VAB essentially, and at the pad about 4 weeks. In parallel, of course, we have again two prime flows that we talk about here. One is the orbiter flow from landing to launch again. But at the same time that's going on, we have parallel activities offline on the solid rocket boosters and on the external tank. They are then stacked up on the mobile launcher independently. When the orbiter is ready to mate, it is taken on over and we then mate it to the tank and the SRB's, which have been mated previous to that time. I'll show you a little later that some of these off-

orbiter flow times now are taking as long as the orbiter flow times themselves.

Here is one quick chart on the STS–3 retrieval system (figure 15). As you know, we recover the solid rocket boosters. They are parachuted into the Atlantic and then we bring them back by special retrieval ships. They are disassembled and sent back for reuse and overhaul. The vessels have gone through their first scheduled drydock. We've had them over a year now, and they've been recertified and are ready for use on STS–3.

We did have some problems on STS–2. We had very, very heavy seas during retrieval operations, and it took us a considerable amount of time to recover them. We got a very good test of our retrieval and recovery systems under very high seas, but we had a few problems. We have a special tow link in the towline which was there to protect the flight hardware so that if our tow loads exceed the capability of the flight hardware, these links will break. We broke a couple of those links last time and as a consequence we've had the design modified now to increase our tow link strength. So we expect to have less trouble with that. They made a few changes to the link. As you know, the solids float vertically and we have to get the water out of them so that they'll come over and float horizontally. That's done with a special dewater system, which we call a barb. It's operated by divers and we did have a little trouble. In fact, on the high seas, one of those barbs broke and came out, so we've made some changes which are relatively minor, and we think they're OK now. We also failed to separate the nozzles on STS–2. We changed the separation scheme and they separated at a lower elevation this time than they did initially. When we fired the nozzle separation charge, it failed to operate; as a consequence the nozzle stayed on and we incurred more damage to the skirts than we desired. That wiring arrangement has been redesigned now so that we won't get the same thermal and aerodynamic loads that failed those wires before. They've been strain-checked so that shouldn't happen. Also, we have added some stiffening to the aft skirt now to minimize that water impact damage.

I'll quickly go through the same summary data on the rest of the missions up through eight. For STS–4 (figures 16 and 17), we don't require any powered-down mods; there are some powered-up mods. We don't plan to do the dry CDDT on STS–4; the cryo tanking test will be done; and the orbiter still lands at DFRC. This is the last landing at DFRC under present planning. These are the milestones that we're now showing as being required for OPF work, VAB and the pad. DFRC requires 11 days for the landing. These are the projected dates. It does show a planned launch date on the Fourth of July. As Dick mentioned, this is the first mission which has a classified payload. This particular payload is installed at the pad rather than in the OPF—the first one to be installed there.

STS–5 does have a lot of powered-down mods required (figures 18 and 19). We have to conduct what we call mini mods to this one because of the mission that's going to be flown. It requires a fair number of modifications before it can be used for that mission. There's 28 days powered-down time which gives us some serial impact. We will have Orbiter 099 here during this operation so we will be doing parallel operations in the OPF with Orbiter 102 in

one bay and Orbiter 099 in the other bay. STS–5 lands at KSC. Orbiter 102 (Columbia) is planned to go back to Palmdale for additional modifications after the STS–5 mission. It's scheduled to go back there for 6 months. After we land it here, we plan to prepare it for return to Palmdale. We take the OMS pods and the engines off at KSC and they'll remain here. We do have to decontaminate the forward RCS system, and once that's done it is ferried back to Dryden and transported overland to Palmdale for that mod period, which is about a 6-month period. So this again shows the time, and this is much longer than previously experienced primarily because of these mod periods. Pad operations, and a 5-day mission are shown here, and this is the time before we ship it to Palmdale. It's 136 work-days, so it comes back here on June 25, 1983.

Mr. FLIPPO. Dr. Gray, this will be the first one to land at KSC, but it has to go to Palmdale for 6 months. Why not go ahead and land it out there?

Dr. GRAY. The original plan was to do exactly that, as a matter of fact. But the problem with landing in Palmdale is that we really don't have a full-time crew out there to accommodate it. Now when we land at Dryden we have to send upward of several hundred people out there. We have to send a deservicing crew, the safety crew, the medics, and we have a lot of equipment that has to be used with it. So the cost involved with sending a whole team to do the deservicing and this kind of work at Dryden is about $1 million for every landing out there. Second, some of the equipment is not available to do a total deservicing of things like the OMS pods or the FRCS. So, in summary, once we looked at the whole thing, we decided it was far cheaper and better to bring it here and prepare it to go to Palmdale because we can take the OMS pods off—we can do total deservicing. We've got the crew here; we've got the capability here. The only time we're really talking about is a couple of days ferry time. So it turns out it's just as fast and far cheaper to do it this way. Now this plan may still change, unfortunately. However, this is the best way to do it, we believe.

There are still some people who think they may not have their landing objectives done by the STS–4 mission. And there's some talk about wanting to land STS–5 at Edwards anyway for additional crosswind data. If there are some mission requirements to do it and it is landed out there, then we will work up a different plan, but it will cost substantially more money if we have to do it out there.

STS–6 is the first flight of Orbiter 099 (figs. 20, 21, and 22). It has several firsts—it'll be the first flight for these. It arrives at KSC on June 30. It's also the first flight of the lightweight external tank and the first flight of the lightweight SRB's. It'll be the first TDRS/IUS combination. There is a special test required that takes some additional time here, and you'll see that in the flow. We need to run a special dynamic stability test wherein we put a pathfinder IUS and a full-scale model weight simulator in the cradle and run some dynamic motion tests. We can see what kind of feedbacks we get into the structure and the control system. There will be a cryo load test again on this one because it's the first flight of a new tank configuration. I had mentioned earlier that the OPF activities go on in parallel with Orbiter 102. This is the first use of some of

these second line facilities. The second bay of the OPF and control room No. 2 also will be used for the checkout of this one, and it will be the first use of the second mobile launcher. There is some work that comes with Orbiter 099. The engines will not be installed; we'll put them on here. The OMS pods will not have gone through their checkout. We also have to do that. And there will be some other scheduled mods that will be transferred down here. The planning is to land at KSC presently. There has also been some discussion on that one by the flight ops people. They say, "This is the very first flight of Obiter 099. Do you want to land that at KSC the first time or might you not want to land that back at Edwards?" So, right now the baseline says it will land here. If some of the flight ops people have their way, it may end up landing there for one time just to check its aerodynamic landing characteristics. We don't know whether that will change or not. When these things change it's very important because, once again, if the plan changes to a landing at DFRC, it adds about a couple weeks to all the downstream flows—plus the money it costs us.

Some of the milestones for STS–6 are shown here. Once again this flow is very, very long for several reasons. One of the main reasons is that the first flight of this particular vehicle will require a more extensive checkout. We have to run this dynamic stability test. We run a cryo tanking test at the pad, so that adds time. This shows us back into January 23 to launch. Right now the plan for that is January 20, 1983. Shown here are things I've mentioned. This is the first flow of this vehicle, first use of these facilities, first time we've done two-in-flow and, of course, any slips we have in those upstream launches could affect this launch directly. This is that total flow and, as you can see, the OPF time here is substantially longer than for the previous mission. The dynamic stability test consumes a fair amount of this time right in here. There's still some work as to exactly how that will be done. The flight engines are now planned to be installed for that test. They may or may not support that early test. We probably can't change that test. We may have to put engine simulators in and run this test and then put the flight engines in downstream some place, which we can do.

STS–7 (fig. 23)—we're now getting into what we consider approaching our stable operations. There are no powered-down mods identified right now. The pods stay on. There is no dry CDDT and there's no cryo load so that these times are now beginning to move down a little bit. We do show the launch for STS–7 on April 20, 1983.

For STS–8 (figs. 24, 25, and 26), we have set that up for the minimum amount of testing. We think we're approaching a stable turnaround. There are no mods and we expect to have minimum TPS work. These are kind of the days we're projecting in the various areas for that particular mission. This is what we think represents our operational turnaround rate, and I'll talk a little more about that later. This also has a launch on the 4th of July. We like the 4th of July for launches.

The thing that we find as we look at these outer flows is that most of the effort that's required is mechanical tests, so to speak, rather than testing. We've had a lot of people say that we keep on testing and testing all the time. Well, the facts are that we could

delete virtually all the testing and not take a lot more time out of these flows. As you can see, the critical path here is essentially all engine maintenance on this particular flight because there are a fair amount of engine tests and checks that have to be done. These are most mechanical tasks. You always have the thermal protection system to repair, plus putting payloads in and out. So, it's really just the mechanical tasks that you have to do, and there're just not a lot of variances that we can do with those.

So, to summarize those launch dates for you, this is what they look like (figures 27 and 28). For STS–3 March 22, July 4 for 4, November 11 for 5 and so on. In the handout you have this chart available to you, but it shows Orbiter 102 and the missions we've just talked about and Orbiter 099. You can see on here the varying length of these bars. This was the STS–5 long period because of the mod which was substantially longer than this one. This shows the offline activities which start, in the case of the aft skirt assembly for the SRB, well in advance of any mate with the orbiter. This shows STS–3, 4, and 5. It shows STS–5 going back to Palmdale for the mod. It comes back at the end of that mod period, which is after STS–8, and finally is reused on STS–9 in our present plan. This shows the first flow for 099 here, going down to this flow here that I described for STS–8.

Now this is an interesting chart (figure 29) because in a way it really collects all the data I've just shown you. We've got 1 through 8 with the orbiters being used, and these are the times in the OPF, the VAB, and the pad for the orbiter. This shows the planned times and the actual times for STS–1 and 2 and part of STS–3. As you can see, for STS–1 we were in the OPF for 610 days and there were reasons for that. Ninety-nine days are shown for STS–2, substantially less for STS–3, 55—and we do not have the mods—and 35. These were the big mod periods but, as you can see, our target for STS–8, which I just showed you, is 28 days. This is a substantial reduction, or nearly half of what we're doing today on STS–3, and substantially less than what we started with. The same thing occurs with the VAB. We continue to have the same reductions, getting down to 12, which again is somewhat less than what we have planned for STS–3. This is considerably less that what we have planned on the pad for STS–3. These are just a summary then of the mission times and the others. We do project, in fact we've shown considerable advancements here in getting these times down, being able to do much better.

Mr. FLIPPO. About 60 days then is what you anticipate?

Dr. GRAY. It's 59 days. Now I'm going to show you a little more about that because that's 59 days based on the data I've just shown you. The next thing I want to talk about is that we do believe there's still some more learning which we can acquire from that point on. We've found that we're learning as we go. In some cases, we've learned faster than we expected, and in other cases, not so. Second, we are indentifying all the constraints to these turnarounds. While there are hard constraints in some cases, you make improvements to minimize these times. So, we're trying to identify all those. I'm going to show that if we make some modifications to the way we do business with the flight hardware and ground sys-

tems, we can improve these turnarounds. I'm going to show you what our forecast for that is.

These are traffic rate requirements again (figure 30), as I showed you earlier. We have one anomaly in 1989, but it's 18 max essentially, with 15 during the time periods shown. And if you go summarize the data we just gave you, the 60 days you mentioned is about 59. It's broken up this way, but there are other critical path operations.

The pad refurb time isn't extensive as right now (figure 31); it's taking about 6 days. The mobile launcher takes a while before it's ready to do anything with either before we can restack, and that's on the order of about 6 days. Aft skirt build up is 12 days. Now that's offline work. That is not done on the mobile launcher, but this is. So it's 20 days' processing time, which is very large. The SRB's and the ET's are stacked on the mobile launcher, so that consumes mobile launcher time. That's where you get to the mobile launcher utilization time. You find that the refurb, the stacking—and, of course, it has to go through the VAB with the orbiter and on to the pad—all consume time. You find it's 57 days then for each mobile launcher flow, which is only a few days less that the orbiter. So right now the orbiter and the mobile launcher flow times are essentially the same.

Now if you take that data, and it does need a little adjusting, but if you take that data, this (fig. 32) shows what our launch rate is with one pad, two mobile launchers, three mobile launchers, two pads and three mobile launchers. We find that we can really only get up to 14 launches using that data I just showed you; and we get up to a level of 3 mobile launchers, which doesn't occur until 1986. Again, that's based on this kind of shifting and that really doesn't meet this mission model. It meets you on through May 1984 and possibly in 1985 but it does not meet mission models, so we've got to do better than that. Now, when you take the STS flow and talk about the improvements I mentioned, here are some things that we're looking at and collecting in operations improvement (figs. 33 and 34). We've talked about deleting of testing, trying to find what additional tasks we can do in parallel, streamlining of inspection, a paperwork system, and other processes so as not to slow the job down. Methods of work processing, how we can operate the file system quicker, changing contracting schemes—Dick mentioned that—are all being considered. The SPC, we think will minimize the number of interfaces involved so that some of this work can be accomplished faster. More automation techniques, which in some cases required additional equipment, will, we think, speed up quite a few of the processes. We're looking everywhere at all the ground and flight hardware changes that we can make. Better access, better platforms, different crane arrangements and things will allow us to work faster. The SRB's presently are probably the most critical path that we have. They have literally thousands of pieces of hardware that have to be attached when they get stacked up. It takes only a relatively short period of time to stack the individual segments, but then to attach the various cable tunnels, cable trays, all the fasteners that go on, the heat shields, all the pin closeouts, and all the thermal protection system takes time. It's a very extensive job. And there's a very active effort underway to make a lot of

changes to those systems so we can speed that up. Part of the same thing applies to the external tank, and some items apply to the orbiter. These are the kinds of things that we are becoming aware of by looking at the processes we go through and the times we take to do certain tasks. We're collecting potential design changes that will help us speed those up.

As to what we think that will do to us, these are the numbers I showed you before for STS–8 (fig. 35). Once we make all those improvements this is what we are targeting or hoping to be able to achieve. We think it's quite optimistic, but hopefully it is achievable and we get down to these kinds of days—13 days in the OPF, 7 days in the VAB, and 10 days on the pad. So we get down to a 30-day orbiter time now. These other items are also reduced, but now you find that the mobile launcher time exceeds the orbiter. So, this is what I told you before. Right now it simply says that for every flow, we've got the orbiter sitting around with some idle time if we achieve this time for the MLP and don't better it. So, of course, this is one of the areas we're going to have to concentrate on right here to see how much better we can do. We think we've got the orbiter to a point now where we understand what we can do with it, but with a maximum of 3 orbiters and 3 mobile launchers, our constraints are still going to be the mobile launchers. With two, it's hopeless.

Now this is just a summary of that to STS–30 without improvements and STS–30 with improvements. The chart I just showed you would be about STS–30 time and all the learning we think we can put in plus the improvements, and these are the stay times which I just showed you. These are about the capabilities per year (fig. 36). For example, one pad has the capability of about 17 per year, we believe. The mobile launchers, as you can see, get up to about seven and one-half under the best of cases and the orbiter about the same range. But until we get those improvements we're talking on the order of about 5 per year for these, and even with three mobile launchers that's only 15. You really can't get up to your maximum rate and you're very, very marginal even at that. These again are essentially maximum. I'll show you in a minute what happens when you adjust those. You see, these don't really account for any inefficiencies or, in fact, any peculiar configuration. For example, we may have one payload that, because of its weight or something, has to use a certain orbiter. Well, maybe that orbiter isn't ready exactly when you need it and there may be some lost time trying to phase these. Also, you may have some pad interference during this time. So this really represents the best you can do, and when you adjust that to real life you can't achieve it. This is what we think it yields when you get out to this time frame. We think that you get 15 with one pad and 2 mobile launchers. It goes to 17 with three. This now is constrained with the one pad only. Once we get everything online we hope that we're up in the order of about 20 per year.

Mr. BRANSCOME. Does that mean to get beyond 20 you'll probably need another mobile launcher platform?

Dr. GRAY. I guess I would answer it this way. Unless we get quite a bit smarter than we are and manage to make other substantial improvements in the hardware designs and so on that we can turn

these things around faster, we would have to have a 3d mobile launcher or a 4th mobile launcher. I can't forecast that today. We have mixed opinions on whether we can reach that rate or not. Optimistic people believe that we can do that and pessimistic people say we're not sure we can. So it would be hard to answer that. We either have to improve and be able to do things like the mobile launcher SRB stacking, ET stacking, and closeout considerably faster, or it would take an additional mobile launcher. You have, well there's one other thing you could do. You could go to a little bit more extended shifting, but not much. We're working virtually around the clock now, but you could throw in another shift or two possibly on a Sunday, and pick up some of the time. It probably would take another mobile launcher. Now that probably isn't important anyway until you get another orbiter because the point is that you're tied to the orbiters as well. But if you were to have 4 orbiters down here, then you probably would need another moble launcher.

The final chart is just a pictorial of all that business (fig. 37). These are the years the orbiters are arriving online, additional facilities, mobile launcher 3, pad B, and these are the turnaround days here. These spikes are the new orbiters coming in. But it does show that we're talking about substantial improvement. And this is the level that we have to get to, that I showed you over here, to get down to that 20 per year. So it's a big jump from here to here but that's what right now we're hoping to be able to do, in trying to put our plans together to allow us to do that.

And that was all I had, Mr. Chairman. Tom Utsman is next.

Mr. FLIPPO. Thank you, Bob. I appreciate that.

Mr. UTSMAN. As the agenda shows (fig. 38), I am going to cover where we are in our operations era contract planning. Dick foreshadowed almost everything I was gong to say so I'll try to fill in the gaps and emphasize how we're going about it, and the continuity with the background of where we've been. It stretches back to 1976 and has been a continuous process to what's going on today. I'll use the same schedule Dick used earlier to wrap up and show where we're going.

Two years ago Andy Pickett briefed the committee in detail, and I'll just pull the highlights out for continuity. The aerospace study question was how should we operate as an agency given that we've progressed to a reusable space system (fig. 39). Aerospace looked at that and concluded that—from all the models of quasi-public agencies, DOD, DOT, and so forth—NASA should operate and make provisions so that the system could go commercial at a later time. Then, a NAPA study came to similar types of conclusions. Based on those studies, we were asked to take a look at Kennedy—how we would fit into the framework and how we would operate down here. We also were asked to have an outside agency take a look at it. Through the procurement process, Booz-Allen-Hamilton was selected to run an operations study. This study focused primarily on how we would operate the Shuttle here without regard to the basic institution, expendables, or any of the other activities—a very narrow focus because again it wanted to do the kind of trades that would say what area and what arena we should look at. Based on these results, we had an in-house study, chaired by Gerry Griffin,

which looked at the results of the Booz-Allen, took a broader brush, looked at how it affected the institution, the total roles and missions, and came out with these basic summary results (fig. 40). It said that we should select by competitive means two self-sufficient, and I'll come back to that word again, contractors for processing STS launch vehicles and cargoes; a third major contract to run base operations; and several smaller contracts to be retained and managed by the Government. It noted there would be fewer civil service required to manage a mature Shuttle operation because (1) the Shuttle would be an operational vehicle, and (2), the management style would require fewer people in the civil service ranks than we have traditionally staffed in an R. & D.-type program.

Based on this, the Shuttle processing contractor is primarily responsible for ground operations associated with launch and landing (fig. 41). The cargo processing contractor is responsible for preparing the payloads so that they are ready to insert in the orbiter's cargo bay. Base operations is to run our installation. And this is where it gets important—conceptually there are many systems that cross boundaries, such as the power system. We wanted to make each of the contractors an operating entity and make them self-sufficient—not for the reason of self-sufficiency but to make them feel fully responsible for their activities. Self-sufficiency is a result, not the purpose. The purpose is to give the responsibility and the means to do a job to the person who has that job.

Mr. FLIPPO. Is there anything to be gained by perhaps combining the BOC with the military contract?

Mr. UTSMAN. In the BOC area, we don't feel there is. You're talking about with the Air Force eastern test range?

Mr. FLIPPO. Pan Am.

Mr. UTSMAN. No, not as a joint contract. I'm sure you're aware we have joint service contracts where we have worked through the areas we can cross-utilize and have common missions. We ran studies that started back in the 1960's in order to do that. For example, our photographic services, propellant delivery and storage, and medical services are consolidated with the same contractors operating for both KSC and the Air Force, so that we essentially get the economies of scale. So we've done that. When we've looked at these other arenas, we haven't found much commonality. Both we and the Air Force reexamine the potential each year.

Mr. BRANSCOME. What happens for DOD? Is the cargo processing contractor included for DOD?

Mr. UTSMAN. No.

Dr. GRAY. DOD will handle their own classified payloads. Now they may get involved in some unique cases. For example, when we have a classified DOD payload and another non-DOD payload to be launched on the same Shuttle, they have to go through the Vertical Processing Facility and be made up into a cargo. That then goes through a KSC facility and there would be an interface there. KSC would be involved in making it into a cargo. Of course, that gets turned over to the Kennedy operators when they put it into the payload bay, but in terms of processing that payload, the Air Force does that exclusively in their own facilities.

Mr. BRANSCOME. So they would continue to have some activity here?

Dr. GRAY. Yes.

Mr. FLIPPO. Do you feel that we really have a thorough understanding of that CPC aspect of it? It's obviously the most complex because that's the reason you had it further downstream in the implementation program.

Mr. UTSMAN. No. I'll make the point later on that. Essentially we feel there are two factors complicating the cargo processing contract: (1) the manifest shifting, where it is difficult to define the work early on; and (2) what work processing we really ought to do. My own personal opinion is that we were much better prepared to handle a Shuttle operation—launching and landing—than to face what it takes to handle multiple payloads that involve different people, different characters that must be integrated into a single cargo. Our experience with multiple payloads with the military has been similar people, similar missions, similar customers. Here we're going to have to deal with three and sometimes four different customers in the same payload bay, the same cargo, with constraints. There are technical difficulties but it's mainly in how do you satisfy the needs of all the customers. And frankly, the first launch hasn't prepared us, nor the second, and we're really going to need time to learn what that's about. That's the two major areas I see that complicate that world.

Dr. GRAY. I think you're right, Tom. We really don't understand that well enough. That's probably the reason it is downstream. We've got to understand that better before we can decide how to do that. We probably understand the Shuttle processing well enough.

Mr. UTSMAN. Or a single cargo. I would emphasize a single cargo is again similar. It's that multiple cargo that is different.

Mr. FLIPPO. Yes. It just seems to me that that is going to have a major impact on the cost of flying. It could be both negative and positive. We may not know yet. It seems like it could have such a tremendous impact on the cost of use of the orbiter that it's something that we really need to look at. They may be the marketing agent, I don't know. If they understand what it takes then that's going to go all the way into the design of the payloads and everything else.

Mr. UTSMAN. That's right. Well, the only one we have anticipated here is only for our processing activity. It wouldn't include the activities of the design. Again, as you remember, the original one had that all integrated.

Dr. GRAY. What he's referring to, Tom, is that the process we have to do here, and how we decide to do that, can ripple back into the design. In other words, the handling requirements, integration requirements, safety requirements, or whatever, can all ripple back. And you're right. If you fly a Shuttle for $25 million and it cost $400 million for the payload, then you probably won't have too may payloads around either. So that's very important.

Mr. UTSMAN. Yes. That's right. we are, for example in just one area, looking at the safety aspects on what we're doing here to get back with the payload community to find out how much of a driver they are. Are there ways to achieve safe operations in the O&C area that aren't going to drive the payload operators in order to keep it cheap?

Dr. GRAY. Well, it's a handling cost because of the size of the cargo integration crew. You know, if you've got thousands of people the cost per payload is very high, so that must be very efficient as well.

Mr. FLIPPO. That one really needs to be competed very strongly. I guess there may be some concerns about having a single contractor for that.

Dr. GRAY. Well, I'm sure there are. There's also a lot of concern about having a single Shuttle contractor too, as a matter of fact.

Mr. BRANSCOME. What are the terms of the existing McDonnell Douglas contract? Does that have an option that could be—or do you plan to have a separate competition for the cargo processing contract?

Mr. UTSMAN. The current plan is to have a competition for the cargo processing contract. I don't know the exact terms of the McDonnell Douglas contract but it extends through the periods of time that we show on the chart.

Dr. GRAY. It can be extended more but the intent is to complete that.

Mr. FLIPPO. Do you have an RFP out for the CPC?

Dr. GRAY. No; we don't even have a statement of work yet. We're still trying to determine what the content is.

Mr. BRANSCOME. You don't even have a procedure developed?

Mr. UTSMAN. If you go back a couple of years, we had planned for the cargo processing to go first. We set up a source selection board. I think the two problems noted there—plus trying to integrate all the way back into design—it looked like we were premature for the type of definition and understanding for the job. Based on that, the agency canceled the procurement activities. We learned from that and we're going to look at it at a later time period but no earlier than the award of the SPC because we don't want to divert industry's attention away from a very critical job of competition on the BOC or the SPC. So that will come later. And, if we don't have it defined by then, we will be slipping out and we do have ways of handling the problem. But, the earlier we can get it defined, the earlier we can get it completed and the earlier we can get the economies of operation.

After the studies were completed in 1978, we set up a center planning organization which led development of the implementation plans (fig. 42). We knew we weren't ready. As Dick said, we were focusing on the first flight. But, we had a staff officer under Andy Pickett, who continued the planning. To assure the planning wasn't done as strictly a staff element, we set up an advocate group, as we call it, staffed with key members from the center. They participated in developing a comprehensive set of plans to keep going with, so that when we reached the implementation phase we would be better prepared. At the same time, we started communicating this plan as best we could to all interested parties. We've briefed your subcommittee. I've participated in three full briefings with labor on the total plan and I know of at least three others. We have been trying to make sure that this didn't come as a surprise, that it's been a conscious effort stemming from the original work done in 1976 and 1977. There has been a continuous process to make sure everybody understood what we were doing,

why we were doing it, and where we were going. And that's been a keynote all the way.

Mr. FLIPPO. When you say labor, are you talking about in-house employees?

Mr. UTSMAN. We have met with the AFGE in-house. We've met with the business councils. We met, for example, with the regional vice president of the IAM out of the southeastern unit, the Department of Labor, the Office of Management and Budget; we've had several hearings. It's been fully exposed to labor and others.

We started implementation (fig. 43) and, as Dick mentioned, these teams were formed to start transitioning what had been a planning activity to an implementation activity, now, we tried something different that hadn't been done in the past. Normally we had taken planning activities, developed a statement of work, in a prime organization, and then handed it over to a source evaluation board. And what happened was we did not get a free exchange of information with industry and labor from that. We did end up getting lots of questions and a lack of understanding of where we were going. And frankly, in the source evaluation process the exchange of information is very tightly controlled. So we set up something we call procurement development teams. I'm not sure it's an accurate description, but the purpose is to define what the work content is in order to turn it over, as a precursor, to a contract selection group where you have to keep the information flow controlled.

We wanted to interface with industry becau gain, what we were trying to do, was divise a contracting s e that would make industry feel responsible for the job so they could achieve the goals but still find the economies. And, things in the interfaces and the support world that we thought were important, they may not, and vice versa. It was a matter of defining which work scope went in which contract outside of a competitive environment with a lot of the industry people to increase the competition.

So, this activity has been going on since September. We set up a policy overview team, which I lead, to make sure that we transfer the information. The people working on the BOC contract are developing the RFP. We have a group working the Shuttle processing contract. And there are interfaces—or there can be work dropped through the crack. Meanwhile, the cargo activity still has to go on. It still has to fit so we've got to make sure that the cargo planning is compatible with where we're going, and that we don't end up with one contract without regard for what's happening in the other areas. So, that's been done. We also have been reaffirming the directions we are going with NASA management. Dick has briefed Mr. Beggs. We've also briefed General Abrahamson and all the staff offices at headquarters so that we feel we're all going in the same direction. It doesn't mean everybody feels comfortable. It means that everybody is aware of the direction we're going, and if we find pitfalls in this process, we're going to stop, regroup, and know where we are.

Let's take each of the areas (figure 44). In the base operations contract, the development team started in September. We ended up with a lot of informal exchange but we had a formal industry conference that last 2 days. And we got a considerable amount of in-

terest. We gave them a draft RFP—the best product of that development team on what we thought was going in at that point in the selection process—asked for comments, and tried to make sure one last time that we communicated with the industry and they understood where we were going. It was well received. We did have eight labor unions. The questions included, as you might guess, what happens on the Service Contract Act. We tried to answer those questions and generally received fairly limited comments as far as things we ought to do or changes to it. They seem to be reasonably satisfied with the direction we're taking. We have our procurement plan at headquarters and our RFP scheduled for release in early March. And it's working down that road. Our contract award is scheduled for October 1982. The only major perturbations we would see to that would be external activities, such as difficulty with the Labor Department over wage determination—or something of that nature. As far as our internal planning, we are go and don't see any real problems.

The only other variable we're looking at is how long to leave the proposal out to industry. It's bracketing between 75 and 100 days. We've got two opinions. Half of the industry says 75 is fine. We have some saying they'd like 100 so we're going to address it, to make sure that we don't cut off competition or restrict it by going with the shorter time. We're working that.

Shuttle processing contract: We started our development team activities in October 1981. We had two rather unique conferences. They were 2 weeks apart—late September and early October. We wanted to confirm to industry we were moving out on the Shuttle processing contract earlier than anticipated for the reasons Dick noted earlier. And we wanted to tell them this was our planning direction. We also wanted to solicit their comments and feelings concerning whether the plan was feasible and the timing right. We did this, and at that time we also got their comments that they thought the job could be done. The timing was a question. Was it too early to be able to have someone other than the basic developer do the job? With the conference attendees, in these two sessions we worked out an assessment team concept which essentially involves bringing industry in to review what's going on during STS–3 operations (fig. 45). We did solicit industry via Commerce Business Daily. Also, all the major aerospace firms and all the major airlines were solicited. Our criteria was: (1) are you interested in this work; (2) do you have the experience to do it; and (3) are you going to dedicate the resources to give us a good assessment because we want to share the assessment across the board with industry, and to look at the job for whether the plan and timing are right.

The number of respondents that came back in is listed here (fig. 46). United Airlines was interested and it turned out to be the only airline interested. United has shown good interest even though there are only five people down here. They're very high quality senior people and they continue to show an interest in participating in some way in the Shuttle processing contract. Originally, they were talking about priming. I think they now feel that—this is speculation—they would want to participate in a Shuttle processing contract in some form. They think they can contribute to it in a teaming arrangement. The numbers are somewhat misleading be-

cause, for example, United Space Boosters is here, so the 96 participants on the team means they're using some of their specialists here to review parts of the other people's operation and it is not a great expense. But they also have brought people in from other divisions of UTC or another operation. So it is not just USBI as we know it here or at Huntsville. It is really the United Technologies Corp., and this is the corporate vehicle that they're using to manage that activity. We find the same with many of the others.

Boeing Services International is the service arm of Boeing, but they have people in from their Seattle operation, from the aircraft side. They have people in from their compute operations side. So it is really Boeing across the board. Grumman, for example, has 59 people. Nominally, on site full time will be 15 to 18 people, but they will bring in specialists from outside the company to get an assessment for a particular area. Grumman has been very active. Rockwell is similar to USBI, they have brought in other people. Boeing, we've talked about. Lockheed is a non-incumbent. Lockheed has decided not to use their service company but actually has set up a corporate task team that is headed out of their corporate office with participants coming from five of their companies to participate in this assessment. And they've been active. General Dynamics/Convair, Dick said, had 12 down, were very active, and had one of their senior management people leading the team. Their problem came when they started looking at their business base and found they were running short of people resources. They did not think they could continue this activity with the number of people that it would take to stay in competition—facing companies such as Grumman and Lockheed who had committed larger resources and showed an intent to commit large resources, along with the incumbent. So, it was a business decision in their view, and so communicated to us. Martin has a small team but they're an incumbent and they again have a lot of experience. It's a good team and there the numbers do not indicate the quality. It's always very interesting to talk to United Airlines because they have an airlines view of this business, which they recognize is not an airplane. They are not confused that this is an airplane at all. But there is a similarity with the business. And they're always struck when we talk about an operator and a developer. An airline is a guy who operates and owns his thing, but the developer is somebody else, and they bring that set of mind to the job here. The key point also is we did not fund these assessment teams. We selected them but they are self-funding. We're providing them basic facilities and that's the extent of it. The salaries, the per diem and everything else is being paid by these companies. And the results will be coming out in a final report which will be shared with the industry. So based on this process we hope to find out whether (1) the approach is right, and the confirmation so far is yes; and (2) the timing is right—and that's out, still out. I don't think it would be fair to say it is too early, or too late, or just right. It has not been settle at this time in the industry's mind. But that's what they're wrestling with.

Mr. FLIPPO. This aspect of not funding those assessment teams, do you preceive this as a trend that we can expect in the future on NASA contracts?

Mr. UTSMAN. I'm not in a position to set NASA policy so I would say this. It's a sporty venture, but we looked at this as nothing more than an extended preproposal conference. Now the cost can run anywhere from $300,000 to a million and a half or better.

Mr. GRAY. The purpose that's accomplished is education for those contractors to prepare them to bid this if they so desire.

Mr. FLIPPO. Well, is there any relationship between this and the CPC? Do you think in your discussions with these teams, that they feel they will acquire some knowledge in Shuttle processing that may help them in respect to CPC?

Mr. UTSMAN. Yes; they understand the interfaces. And, as you would guess, its difficult to look at just that without looking past that interface and understanding what's going on and how it affects it.

Mr. FLIPPO. Their interest in this may have other ramifications of course.

Mr. UTSMAN. Yes; the teams have been active in looking across the interface, not only at the Center here but they've been looking at what does it involve, how does this interface with, for example, Johnson & DOD, and what are the interactions. They're very interested in understanding the total environmental in which they'll be operating because this will be a sizable contract. And in understanding that total environment, they become interested in the cargo and the total planning. As far as dedicating resources to it, I doubt it, but I'm sure most competent corporate managers are going to know who's been through this and keep tabs for that future activity.

Mr. GRAY. I don't think there's anyone who undertook this assessment with the CPC only in mind.

Mr. UTSMAN. No, they did not.

Mr. GRAY. They're interested in SPC but there would be some fallout for CPC.

Mr. FLIPPO. I was just wondering if they are committing these kinds of resources for the Shuttle processing only.

Mr. MALAGA. I think this really demonstrates the seriousness on their part to go out after that contract. As you can see, the investment is sizable. And when you look ahead to what one must do in preparing the proposal, there's a mounting of the investment. So I think it demonstrates a real interest on the part of these people—a very serious attempt for the contract.

Mr. UTSMAN. Well, the other thing is every one of these commitments have been made with full knowledge and fairly extensive presentations, discussions with their chairmen and their board of directors.

So it has not been a single division sort of activity. It has been a corporate activity, in every one. So it has evoked interest. Now, in the cargo processing, I think I've dwelled on this point, and I think Dick mentioned it earlier, this is just a snapshot of what we're trying to do. Again we want to make sure of the interfaces, and that we don't do anything in these other two contracts that is going to make that work untenable or find ourselves with flaws in it. We're just making sure that what we're doing in Shuttle processing and base ops is compatible even though it may not define it—we're just keeping our options open, keeping it clean. And, we

don't want to set precedents that are going to be bad for that activity.

Civil Service (fig. 47). I always hate this chart because it downplays our bread and butter. George is launching STS and there's just absolutely no question, that's got to be first and foremost in our minds. ELV—the same way. Now, when we get past that, there's a lot of other things going on that resourceswise probably don't measure anywhere near to those activities. But again, when it ties to what we're doing for longer range plans, it's what we focus on. We're trying to arrive at methods across the center on how we're going to do business that's going to be compatible with this responsibility concepts with these SPC's and BOC's. George is taking actions in a lot of the arenas to set procedures in place now, where the risk is appropriate, to operate in much the mode that we'll be in for SPC. For example, on the SRB retrieval, we only have one or two people over there for a managment interface, mainly to assure that the operation's going smooth and there're no problems from external activities. This allows the contractor a much greater feeling of responsibility. He responded in that area, and is doing the job more efficiently and is more motivated now that he's got the ball and it's not NASA telling him what to do. And that's what we hope to achieve here.

We're looking at how we transition. You know that's probably our biggest concern. We've been an R. & D. agency. We've tended to operate in a mode we now call an R. & D. mode. Through our study activity, we have now defined an operations mode. We're working on transition plans. I wish I could lay one on the table and tell you this is the transition plan but it just doesn't work that way. As we learn to operate on STS–1, STS–2, and STS–3—we're looking at those kinds of things and working and trying to figure how it will look when we're talking about STS–9 and STS–10. And those are in work, heavily.

Multiflow operations. That's off the subject of contracting, but we're going to have two orbiters here, come this summer. And that is not a trivial task in that they're not identical. There are differences in how you accommodate them and how you process them. It's not just a manpower concern but also a planning concern, with the technical differences and how you accommodate those.

Again, the cargo work—we're evolving. We're learning and that's part of what's going on.

We're fairly heavily involved in the Air Force activation at Vandenberg. We're providing a couple of hundred million dollars worth of equipment to them and it grows periodically. The Air Force is funding the activity, but we're basically sharing the equipment we development for Shuttle with them. We're also trying to provide them some of the learning we've had in the last 10 years in providing a Shuttle facility so that we can minimize their investment, or at least help them not make some of the errors we made along the way. So that's heavy and getting heavier.

Again, some of the agency's future planning involves what the new thrusts are going to be. We have people who are actively working on those along with members of other NASA facilities. So all in all, when you look at this, we project a heavy workload into 1985. Once we get past that 1985 timeframe, we should be able to divert

to other things. We will be off of the STS operations because it should be operational, should take less to do, fewer contractors, fewer civil service. Managing in a different way should show those savings. So what we're doing is trying to get through this workload and get out there so that we'll have an operational vehicle.

Dick made the major points on the schedule (fig. 3). I don't know if there's much else. Again, we've started, BOC will be out, and the point he made is that although we want the SPC to be responsible for things, that doesn't mean he shouldn't subcontract or make arrangements. But what we're trying to do is get the Government from predetermining what those arrangements are because often we don't understand the situation completely. We want to incentivize these contractors. We're talking about heavy cost incentives, to make those kind of decisions that will drive the costs down. We'll give them the freedom to do so, but keep enough reins on to know that they're not going to do anything that is foolish or detrimental or has a very short term effect. We'll keep the safety aspects. CPC—again we don't want to start it any earlier than the SPC selection because that would divert interest and you're going to have a lot of people interested in the SPC, we think, either as team members or as primes. If you try to get a competition going on CPC, you're not going to get your best. Unfortunately for the industry, there's only one winner on the SPC, which is still going to leave a lot of people interested in the very essential, important job for the CPC. So we just don't want to get that diverted. And then of course we're not going to do it any earlier than we understand what the job is. So those are the two kinds of constraints that are holding up the CPC.

Mr. BRANSCOME. Whom do you expect to bid on the base operations contract?

Mr. UTSMAN. There is a lot of interest. For example, Lockheed Missile, whom we think will team with Pan American.

Mr. BRANSCOME. Is Pan Am servicing the Air Force?

Mr. UTSMAN. Yes, they've been doing that a long time. They also have our medical contract now. They're looking to cross utilize. Also, there are small business members * * *. We have a strong small business program. We feel that we're going to meet or exceed what we're doing today in small business. We're just doing it differently. And I know that some small business people are signed up on that team.

Boeing Services International is going to bid it. There are several other "teamings." We expect that CSC will participate in some form, PRC, Bendix, and others. We expect to see at least two to three strong teams that would give us good competition. As they say, that's "street talk" because we're not really privy to that information.

Mr. FLIPPO. In regard to the small businesses, I might point out that interest seems to be building in Congress to push some sort of small business set-aside this year. I think it's an election year. The impact of further set-asides for small business might be a problem that you should be looking at.

Mr. UTSMAN. If it is a set-aside in the sense that it's managed or governed through small business and we contract with them, it reduces our flexibility in operations. If it is to increase our goals or

targets for small business where we have the leeway of working how they fit into the operation, that doesn't particularly bother us. Our small business people have been good. And that's the intent, we want to keep the small businesses but not to be restricted in where we can really use them, and cross utilize them.

Mr. MINDERMAN. Mr. Chairman, I'm going to give a summary on where the center stands on its facilities program (fig. 48). It will begin with a review of two of the discrete projects in our fiscal year 1982 construction of facilities program, since they tie into some of the fiscal year 1983 projects that we'll be discussing (fig. 49). Since the President's budget has not been submitted to the Congress, we of course cannot outline the precise details of our fiscal year 1983 program. However, we would like to discuss some of the content which we at the center have been submitting to headquarters and negotiating with them, and which we believe are essential for the conduct of the STS program. And finally, we have a special discussion on a requirement for housing personnel in the LC–39 area, which will involve a reprograming action that our facilities people have been working. This should arrive imminently on the Hill from the NASA Administrator.

This is our fiscal year 1982 C. of F. program (fig. 50), and I will review the major discrete projects which tie in to some of the other things we want to talk about later. The first project is the construction of a solid rocket booster processing facility which will be used for the processing of the SRB segments as they arrive here from Thiokol, and also for integration of the aft segments with the aft skirt. This project will be located on this cleared area north of the VAB at Launch Complex 39 (figs. 51 and 52).

This was used as a staging area for the movable platforms that had been removed from the VAB. We removed them for the Shuttle modifications—since of course the configuration is drastically different—and stored them out in this area. We since have utilized much of the material from the platform for various projects. We are now clearing this area, getting ready to proceed with the new project.

The activity in this facility is planned as part of the Shuttle processing contract. The facility provides a large rotation and processing building for the off-loading of the railcars and rotation of the segments to the vertical. It provides two buildings for storage of one flight set in each building. It also provides for the storage of a flight set in the processing building, so that in the event of nonuniformities of the program, either because there's been a delay or perhaps a payload isn't ready, you have some surging capability.

This is an external view of the building (fig. 53). There also is an operations support building. We've taken particular care in planning this facility to insure that all of the lessons we have learned in processing SRB's and solid rocket motors are incorporated into the facility. This is a cutaway of the facility (fig. 54). The solid rocket motors arrive on their special rail cars, and then the covers used in shipment are lifted off and stored in an overhead mezzamine. The solid rocked motors are lifted off, rotated to the vertical, and placed in these support stands on a movable pallet which is a large I-beam type table about 20 feet square. This pallet is the fixture on which we move them around. This shows one of the return

cases from our retrieval facility. And, of course, after we've offloaded a filled segment and put it in this facility, we then put the empty segment on the railcar, put the cover on, and send it back to Thiokol for refilling.

We provided contingency exists from the workstands in this facility into an external confined stairwell system, so people have egress paths. We've taken the crane operations, which became a concern in our VAB operation, moved those off there, and provided egress paths. We removed all personnel housing functions, such as work control and work planning and foreman's offices and all those kinds of things; restrooms, even lunchrooms, locker rooms, none of those are in that facility. They're all in the operations support facility which is separated by a covered walkway and designed in accordance with applicable safety and fire codes so it can be treated as a separate facility. We believe we have a very good facility, and we've been quite successful in working with the designer, DMJM in Los Angeles, to come up with a facility within the project cost. And that's been quite a job because originally this facility was up around $20 million in our early estimate. We've now gotten it down, and we have the 100-percent design packages in procurement, and they will be going on the street momentarily.

There are major pieces of R. & D. equipment which are not a part of the construction project. There is a transporter, which is used to move these very large, heavy segments out of the building and into the storage buildings, and then out of these building over to the VAB for integration (fig. 55). Previously, we had one design for a transporter to be used to move payloads to various facilities in our payload canister, and we had a separate design for a transporter for moving SRM's around. There are unique drivers on each one. For SRM's you'd like to make the transporter narrow so that we don't have to make the buildings wide and expensive. For payloads, of course, you'd tend to make it as large as the canister so that things fit well on it. We did quite an extensive series of trade studies in the past year, and were successful in coming up with a combined design that allowed us to use one transporter for both requirements. In the process we saved about a million dollars. We are on the street now with this procurement, and will be closing in about 2 weeks. In addition to buying transporters for our requirements we are buying them for Vandenberg. That is, of course, with Air Force money.

The second discrete program that was in our 1982 program is the third firing room which Bob talked about, located right in this area (fig. 56). This (fig. 57) is the inside of a firing room. We have this facility under contract now for modification of the old Apollo firing room. One of the things we had to do was move all the people who were using the area as office space out of the building. We're in the process of moving them into a series of temporary housing units that we're locating across from the VAB and that will be integrated within the larger Complex 39 housing project. I will discuss this project later.

These are the discrete projects for fiscal year 1982. Now for the fiscal year 1983 discrete projects (fig. 58). We see a need for an addition to our SRB refurbishment facility. This is used for the processing of the forward and aft structural sections of a solid rocket

booster. These facilities (fig. 59), in which we handle the nosecones, frustums, and aft structural members, will be relocated from the west side of the transfer aisle, across the aisle so that we can make a major expansion of our thermal protection system application and curing areas (fig. 60). We have previously had all those located back in this area. The application and curing of thermal protection on structural components has turned out to be very extensive and time consuming, and very schedule critical. So, in order to expand this area, we have to move out this way, unless we actually expand the building, which is not a cost-effective solution. So we're relocating these functions into areas which are the old Apollo S–II (Saturn V second stage) workstands. They currently are used for storage.

Mr. SMITH. This work area in the low bay of the VAB is really marginal for USBI buildup of the aft and forward skirts. This modification, although it's a KSC facility mod, is in direct support of Marshall activities.

Mr. MINDERMAN. The second part of this project is a series of relatively minor modifications in hangar N on the Cape Canaveral Air Force Station (fig. 61). This is to provide space for the refurbishment and modification of the aft stage components prior to their going to the hot-fire facility for actually testing the auxiliary power units, that is the hydraulic power units that are in these stages. The stages have required more refurbishment and more work than was originally anticipated. This work is presently done in our hot-fire facility, adjacent to the hypergol maintenance facility just east of the KSC headquarters building. This will provide additional capability in hangar N to perform those functions. That's a relatively modest portion of the project.

The other project is for the rehabilitation and modification of payload ground support facilities. This is a series of separate jobs that need to be done at our Delta spin-test facility and ESA 60, our explosive safe area (fig. 62). These facilities were built over the last 15 or 20 years for the purpose of processing payloads and spinning upper stages for various NASA programs. At the time they were built, the safety standards that we applied normally required only things such as sprinklers. The standards subsequently have been upgraded, and current design practice is to provide water-deluge systems. The deluge systems can be activated manually, and are designed to provide large quantities of water in the event of problems in these facilities. While these modifications will upgrade the sprinkler systems to water-deluge systems, they also will upgrade some electrical equipment to a higher explosion-proof classification, and provide emergency lighting and signs for egress routes.

Another payload-related project is an expansion of our data transmission capability from the central communication facility on KSC to the central communication facility on the Air Force's Cape Canaveral (fig. 62).

We had planned the original program on the assumption that the expendable vehicles would be phasing out early in this decade. Now that is not what's going to happen, and we have to retain a capability for processing expendable vehicles well past the middle of the decade. As a result, our ability to use this wide-band transmission equipment for payload data would be overtaxed, so this

project will install a fiber optics cable transmission capability between those two facilities. The new capability will allow us to do payload work for Shuttle as well as the present expendable vehicle work in these facilities.

In the O. & C. building, there are several projects (figs. 63 and 64). One is a third payload-user room. These payload-user rooms are areas where the payload users can come in and set up their particular equipment to work with their payload while it is in this facility, and prior to it being run totally through integration checkout and installed in the orbiter. The architectural or structural work for these three rooms was done in an earlier fiscal year project. We only had need for the first two rooms at the time, but we wanted to get the structural work done so we wouldn't later come in and create a dirty environment in an operating area. This project will install the data transmission cables to allow the payload users to link up their payload or experiment down on the floor up to their support equipment in the user room.

Another part of the project is modification to a series of rooms in the west end of the low bay for a baseline data-collection facility. The facility is used to collect information on the physical performance of the flight crew or payload specialists just before the mission, for comparison first with data that is gathered during the mission and then with data gathered immediately after they land. So, this provides a modification in this area for the installation of vestibular testing sleds for gathering that data. Spacelab 2 will be the first mission to require it.

Now, concerning the performance of Launch Pad A, I have to say, in my view, it was outstanding (fig. 65). The amount of launch damage which we saw is far less than we have ever had on a similar first use of a facility after a major configuration change. Certainly it was far less than we had on any of the Apollo programs although it was still not inexpensive. These numbers include modifying the other mobile launcher and Pad B to correct the problems we had with Pad A and Mobile Launcher No. 1. So, these numbers don't necessarily represent just repair costs, but are the total costs involved with changes that we identified as a result of the launch. The changes were actually quite minor in comparison with other programs.

We originally installed two 5,000-square-foot buildings, one right here (fig. 66). We installed one building here (fig. 67) and one just as you stop at the guard gate to come into the launch complex. We were concerned about this one at the time we built it. However, it appeared to be cost effective if it would work. Subsequently, we decided that we needed additional space for housing technicians, some areas for procedure review and paper cleanup, and at that time we installed a series of old refrigerated boxcars. We did an evaluation and found that a boxcar is a very rugged, stiff structure made out of heavy steel plate, and it would withstand abuse. So, we found a very inexpensive source of boxcars that were available and were being removed from their undercarriages so that the railroads could reuse the undercarriages. We were able to buy these boxcars quite cheaply. We modified and installed this series of boxcars for housing personnel.

This shows a typical view of the inside of the prefabricated building after a launch (fig. 68). A prefabricated building 600 feet from the launch pad just doesn't stand up. In every area there was damage; power was out; ceiling tiles were down; light fixtures were down; air-conditioning ducts were down. We also had debris that was blown off the pad and through the aluminum sides of the building. Basically this turned our to be unacceptable. We fixed it after STS–1 and used it for STS–2 while we were doing our design and planning for what we were going to do after the STS–2 launch. It just would have meant a major refurbishment process after every launch to continue to use the building.

The building outside the gate is far enough away from the launch that it stands up under the environment quite well. So we had a contractor come in, dismantle this building, take it to Pad B, and put it outside the gate. We then went in and installed another series of boxcars where the prefab building had been.

Now, boxcars, you know, are very rugged structures. They stand up well. The only problem with them, of course, is it ends up being quite fragmented space (fig. 69). You like to be able to have big open spaces so you could use it more efficiently. Instead you get 10-foot-wide spaces, which are less efficient to use.

Mr. SMITH. You might explain what he's seeing there.

Mr. MINDERMAN. Yes, this is standing at one end. This is a module, and there's a whole series of these side by side.

Mr. SMITH. This is standing at one end looking toward the other end with the doors open down the middle.

Mr. MINDERMAN. This them becomes a long aisle down the middle.

Dr. GRAY. They're very attractive inside.

Mr. MINDERMAN. Actually they've worked out quite well. You know, there's a side of one boxcar inside that wall and a side of another boxcar inside that wall. We covered them with paneling, carpeted them, put a false ceiling in, and tied it down much more ruggedly than you can do on a Butler building. And they worked out well, and we have not had any damage at all with them.

So that's going to be the housing solution we use in the vicinity of the pad.

Mr. FLIPPO. They are 10 feet wide?

Mr. MINDERMAN. They are 10 feet wide by 50 feet long. We originally put 40 of them in, and now we're in the process of putting in another 10.

Mr. MINDERMAN. It's amazing how many surplus boxcars are available. Apparently, if they don't sell them for things like this, they cut them up for scrap steel. The railroads are in the process of getting rid of their fleet of 40- and 50-foot cars and going to, I believe, a 60-foot car as a standard.

Mr. FLIPPO. What is the height?

Mr. MINDERMAN. We actually dropped the ceiling down to a standard 8-foot ceiling height so we could use standard 8-foot paneling on the walls.

Mr. FLIPPO. It's normally what, about 10?

Mr. MINDERMAN. About 10 feet. This gives room above the false ceiling for our conduit, lights and air-conditioning duct.

Mr. SMITH. What did we pay for the first boxcars?

Dr. GRAY. Less than $2,000 each, which included painting the exterior. We then had to redo the interior with lights, ceiling, and air-conditioning.

Mr. MINDERMAN. When you drive out to LC–39 you will see all the railroad sidings full of boxcars. They're parked everywhere, and we're in the process of installing them. When I mentioned the firing room 3 project, I stated that we made a determination that we had to move those people out of firing room 3. What we plan to do is go ahead and buy the boxcars we were going to need for pad B. And we'll install them outside the VAB just across the street from the Saturn V. We'll use them from now until we have to move them to pad B. By 1984 or 1985, we should be able to determine what our long-term personnel housing solution will be and have a well-understood and accepted baseline of what the total personnel housing requirement is.

Mr. FLIPPO. Those things must make terrific bomb shelters, too.

Mr. MINDERMAN. They are refrigerated boxcars and they've got super insulation. We just put the paneling up, the carpeting, ceiling, add the air-conditioning and lighting and the end result is a rugged personnel housing complex.

The reason we carpeted the floor is that it turned out the floors had all sorts of channels for attachment of dunnage. And, of course, there would have been a great tripping hazard on those because they were very uneven. We initially looked at covering it with linoleum or vinyl tile or something of that sort. But this indoor-outdoor carpet or inexpensive carpet over an underlayer turned out to be the cheapest way to level the floor. And actually it absorbs sound quite well.

We made a special effort to make this fairly nice housing because of the psychological view of "Gee, you're putting me in an old boxcar," and that is important. You're asking people to work long hours and devote a lot of themselves to this program. We wanted to give them a reasonable place to call their office.

We also had some elevator door damage. These are the two main elevators that go up to the tower (fig. 70). It goes from the pad surface up to the mobile launcher zero deck. The door that used to be there isn't there now. It's over next to the building where it went over and poked a hole in the side of the building. It blew about 600 feet from here, about a 7½-foot-high door.

And this is another thing that's sort of typical of the damage we saw (figs. 71 and 72); primarily things like personnel protection, handrails, toe plates, shields to keep people from getting into dangerous areas. If you want to design something so you don't get launch damage, you try to avoid having all the frontal area that the pressure wave can react to. Unfortunately, if you want to keep people's hands out of machinery, you want to provide a big frontal area to keep somebody from inadvertently learning through an area where they shouldn't be. So you are continually fighting conflicting desires. We also had some cases where cables, for example, were not adequately supported, and the blast wave hit them and broke the connectors loose or tore them loose from their boxes (fig. 73). This was the level of the damage that we had.

Unfortunately, there were some press reports that got out that seemed to infer that it looked like—I believe one of the quotes said

it looked like an atomic bomb had gone off. That certainly was not the case.

This is the major modification we had to put in between STS–1 and 2 to dampen out the pressure spike from the ignition of the SRB's (fig. 74). This is a major water header, and then there are water injection nozzles that had to be put in. All of this had to be done between the two launches. These are what we refer to as water hammocks or water troughs (fig. 75). They're nylon sailcloth troughs that can be filled with about a foot of water to provide a mass to absorb the pressure wave, but not to a source of debris which could blow up onto the orbiter and cause damage.

Those were very successful in solving the problem which we had had on STS–1. We got a reduction of the pressure spike at the various locations anywhere from a factor of 4 to a factor of 10. We're going to have to continue with both of these solutions for the next several vehicles while we get additional data to allow us to finally make a determination on just what is the minimum level of protection we have to have.

Now for the second line of facilities. Bob went over what they were. The C. of F. work is done on all of the second line facilities with the exception of pad B, and the C. of F. work there will be completed by June of this year (fig. 76).

R. & D. outfitting—We're quite well along on that. Let me run through where we stand on the various facilities (fig. 77). These are the two bays of the OPF (fig. 78). As you recall, when we built the OPF we decided to build the structural portion of the second high bay prior to the arrival of the orbiter so that we would'nt be out there doing dirty construction work while we're trying to process flight hardware. We did not, however, complete the activation of those facilities. Incidentally, you can see personnel housing scattered around here. That is an area we're also looking at to determine what our minimum long-term requirement is for housing the people.

This shows what an operating high bay of the OPF looks like (fig. 79). This was bay 2 essentially at the completion of construction (fig. 80). And, of course, there's a lot of work that has to be done when the construction contractor finishes. You have the hydraulic equipment, the electrical distribution, the special adaptations to the platforms and so forth. We're in that process right now; it's going along well. We're on schedule for completion by June 30.

The facility job in the VAB is basically completed (figure 81). There are some minor modifications to the facility which we have identified in high bays 1 and 2. The design is complete and we're on the street right now for this work. We also included the package for the overpressure modification on mobile launcher 2.

The mobile launcher itself (fig. 82) shows a mobile launcher as it is completed by the construction contractor (fig. 83). As you can see, the tail service masts, very large structures that carry the umbilicals and fueling lines up to the orbiter, are not there yet. We're now in the process of moving this mobile launcher into the VAB where we'll begin connection of the installed systems for electrical and pneumatic with the systems in the VAB and with the firing room. And we'll be starting our checkout activity very shortly. We're scheduled to be in the VAB a week from today.

The construction portion of pad B is moving along well (figs. 84 and 85). Contract 3, which is the installation of long-run piping and cables, is about 75 percent complete. By June of this year we'll have the construction completed. We're now updating the design of the R. & D. packages for the GSE that go in there and are working toward a September 1986 operational date for that facility.

Now the housing question for LC-39. We've had a number of reviews of the issue of housing people at LC-39: "What's the minimum essential number of people requiring housing and where do we put them?" The results of those reviews were presented to the Administrator along with our recommendations in the fall of 1981 (fig. 86). We were told to prepare the necessary estimates to move all of the non-hands-on people out of the VAB. In other words, we would move the operations support people and the ancillary people out of this area and leave only the operating personnel in the VAB. They would be moved out to a site that we would propose locating right here (figs. 87 and 88). We have completed the PER (preliminary engineering report) which we did in connection with the 30-percent design on that project to make sure that we had a good understanding of the cost of that project.

NASA Headquarters has completed preparation of the reprograming package and it is on the way to the subcommittee (fig. 89). It will provide for the necessary site work to accommodate approximately 200 office-type trailers or housing modules. It includes preparation of the site and installation of the underground utilities—sewer, water, communications and power. Our present cost estimate is $2.7 million for the site work. The R. & D. cost associated with the project provides for the placing of the trailers and the rental cost from the time they're installed until such time that a permanent solution could be built. The cost for moving people into those housing units also is included.

Mr. WILLIAMS. Is this a budget restriction?

Mr. MINDERMAN. Leasing them as opposed to buying them?

Mr. WILLIAMS. No, not buying them at all, but building a permanent structure. We've got the situation for example, at Livermore where we've leased trailers and they've been there 10 years. The lease cost has exceeded the permanent construction cost by 200 percent. And I'm wondering how much we pay per year for the lease of these trailers? I also see you have it under R. & D.

Mr. MINDERMAN. Within the agency the lease of trailers is normally funded out of R. & D. or R. & P.M. The facility work to prepare the site, essentially those things that we put in the ground and can't move, we charge to C. of F. for the appropriate facility project. If it's less than $75,000, of course, we do it out of either R. & P.M. or R. & D. funds. Anything that goes in the ground and can't be moved is considered facility work. Anything that is relocatable and could be moved off the center, we do not consider to be a facility project. As far as the reasoning behind the project, there are questions in people's minds of what is the real long-term requirement. As Tom said earlier, we expect a savings in manpower of at least 20 percent when we go to the SPC. But what is that real number? You can get a lot of different numbers. I think there's a strong feeling that it would perhaps not be appropriate at this point in time to facilitize for the number of people that we have a

need for this year. There also are people who will say when you start getting the higher launch rates, all the efficiencies we're going to gain will end up being eaten up in launch rate.

I don't know what the right answer is. I think there's a strong feeling that it's really appropriate at this point in time to go ahead. We had talked to NASA Headquarters about building a 250,000-square foot permanent office building, which is kind of the ballpark you start talking about. We worked up some preliminary costs and some estimates. We've been working with them in the formulation of our outyear budget plans to scope what a building would cost at the time that it's appropriate to build one. But right now we don't think that it's the appropriate time.

Mr. WILLIAMS. What is the lease cost per year?

Mr. MINDERMAN. Lease cost per year is around $900,000 depending on when the trailers are actually delivered to KSC. This lease includes an option to purchase. We estimate that about 50 percent of those lease costs will flow through as a purchase credit, so that after about 3 years, one could exercise the option to buy for what you would have paid for the next year's lease.

Mr. SMITH. Now the other thing that has to be considered besides the uncertainty that Pete talked about is the time and the urgency of getting that housing and getting the people out of the VAB. We have worked the safety issue in the VAB long and hard. You know we've got a lot of nice areas you could use for office space in that building. However, you've got those SRB's in there. We're also processing ordnances in the VAB and we just would never satisfy ourselves that that would be a prudent thing to do.

Mr. MINDERMAN. This is the site plan (fig. 88), and as you can see, this is the number of trailers in each module. We call them trailers; they do get moved in on wheels and you buy them from a trailer company. But this is a fairly common type of modular personnel housing used througout industry. They come without side walls and you put them in and bolt them together, and make them as big as you want. We have a number of modules out there right now and they make nice housing for people. They've not as energy efficient as a permanent building and they have somewhat higher O. & M. costs, but they are very efficient for housing.

In addition to the housing units, there are two groups of boxcars (fig. 88). These are the ones I was telling you about and they are being put in as a portion of the firing room 3 modification program—the site work is, that is. These are the boxcars to house the people who were displaced by the firing room 3 project, so, of course, that's the appropriate place to include those costs.

That completed my discussion, I'll be glad to answer any questions you might have.

Mr. SMITH. That completes our prepared presentations.

Mr. FLIPPO. Thank you very much. We appreciate the briefings. They were very informative and will be very helpful to us.

We would like perhaps to follow up with some questions in writing.

Mr. SMITH. Well, it's a pleasure to have you here today.

Mr. FLIPPO. The hearing is adjourned.

[Figs. 1-89, plue the statement of Mr. Smith follow:]

KSC ORGANIZATION

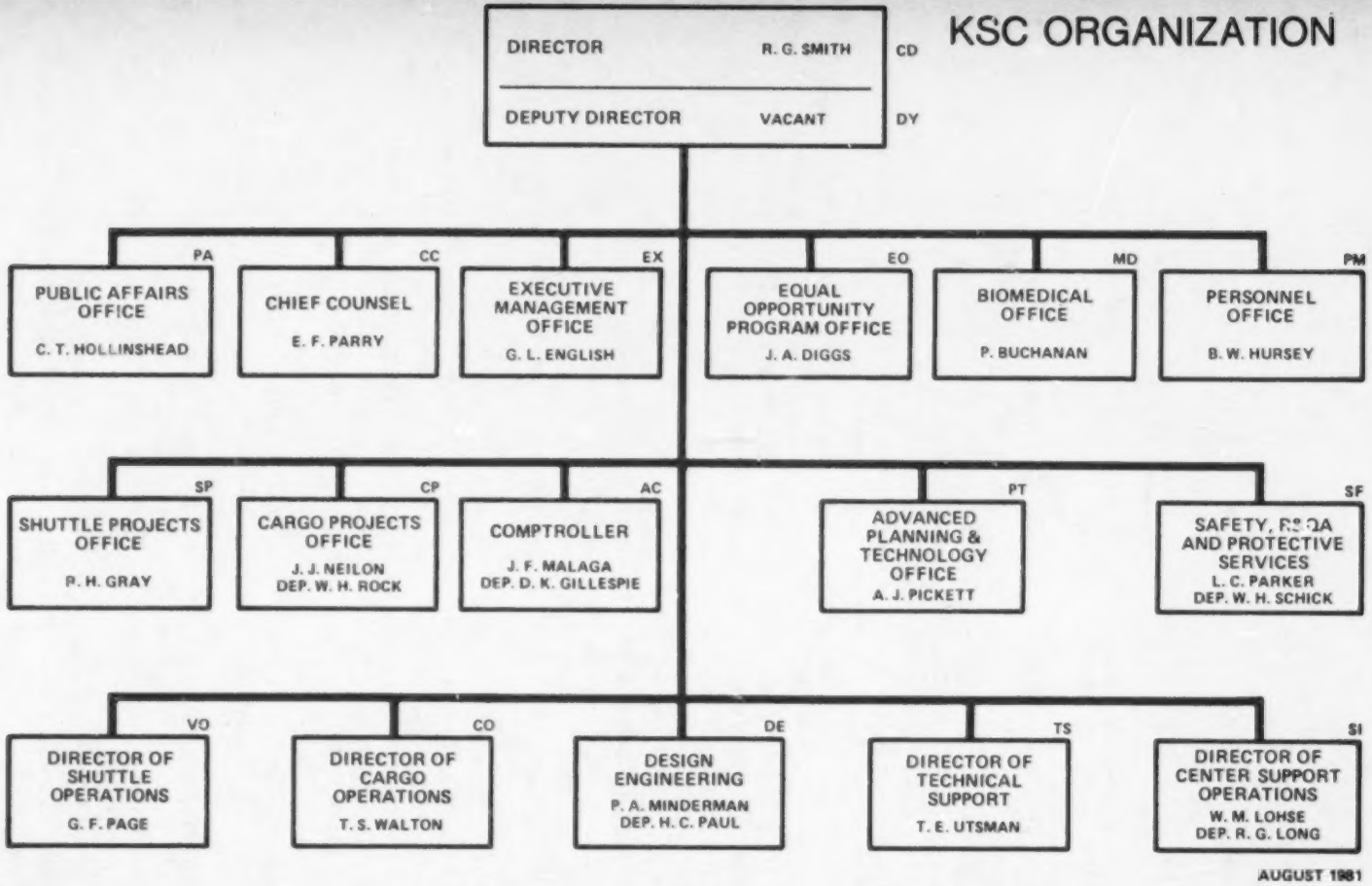

Figure 1

EXPENDABLE VEHICLES LAUNCH SCHEDULE

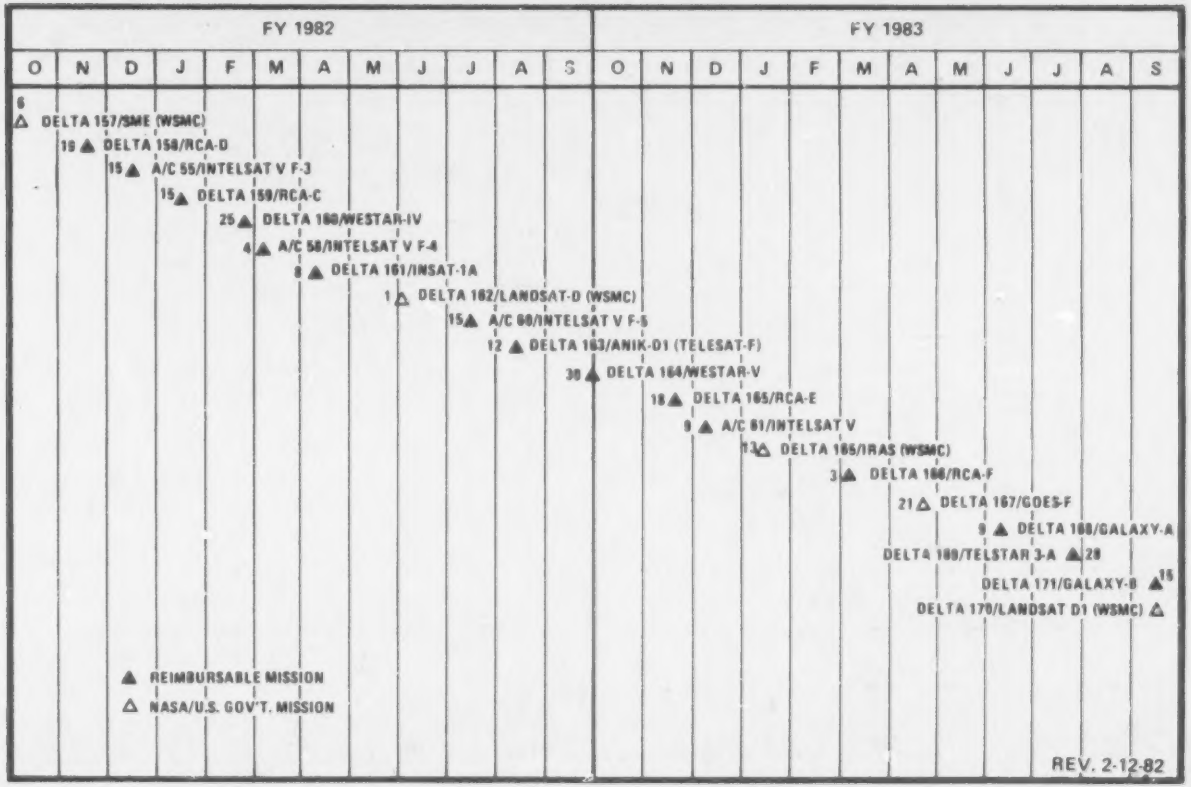
FY 1982
FY 1983
O N D J F M A M J J A S O N D J F M A M J J A S
6 △ DELTA 157/SME (WSMC)
19 ▲ DELTA 158/RCA-D
15 ▲ A/C 55/INTELSAT V F-3
15 ▲ DELTA 159/RCA-C
25 ▲ DELTA 160/WESTAR-IV
4 ▲ A/C 58/INTELSAT V F-4
8 ▲ DELTA 161/INSAT-1A
1 △ DELTA 162/LANDSAT-D (WSMC)
15 ▲ A/C 60/INTELSAT V F-5
12 ▲ DELTA 163/ANIK-D1 (TELESAT-F)
30 ▲ DELTA 164/WESTAR-V
18 ▲ DELTA 165/RCA-E
9 ▲ A/C 61/INTELSAT V
13 △ DELTA 166/IRAS (WSMC)
3 ▲ DELTA 168/RCA-F
21 △ DELTA 167/GOES-F
9 ▲ DELTA 169/GALAXY-A
DELTA 169/TELSTAR 3-A ▲ 28
DELTA 171/GALAXY-B ▲ 15
DELTA 170/LANDSAT D1 (WSMC) △
▲ REIMBURSABLE MISSION
△ NASA/U.S. GOV'T. MISSION
REV. 2-12-82

Figure 2

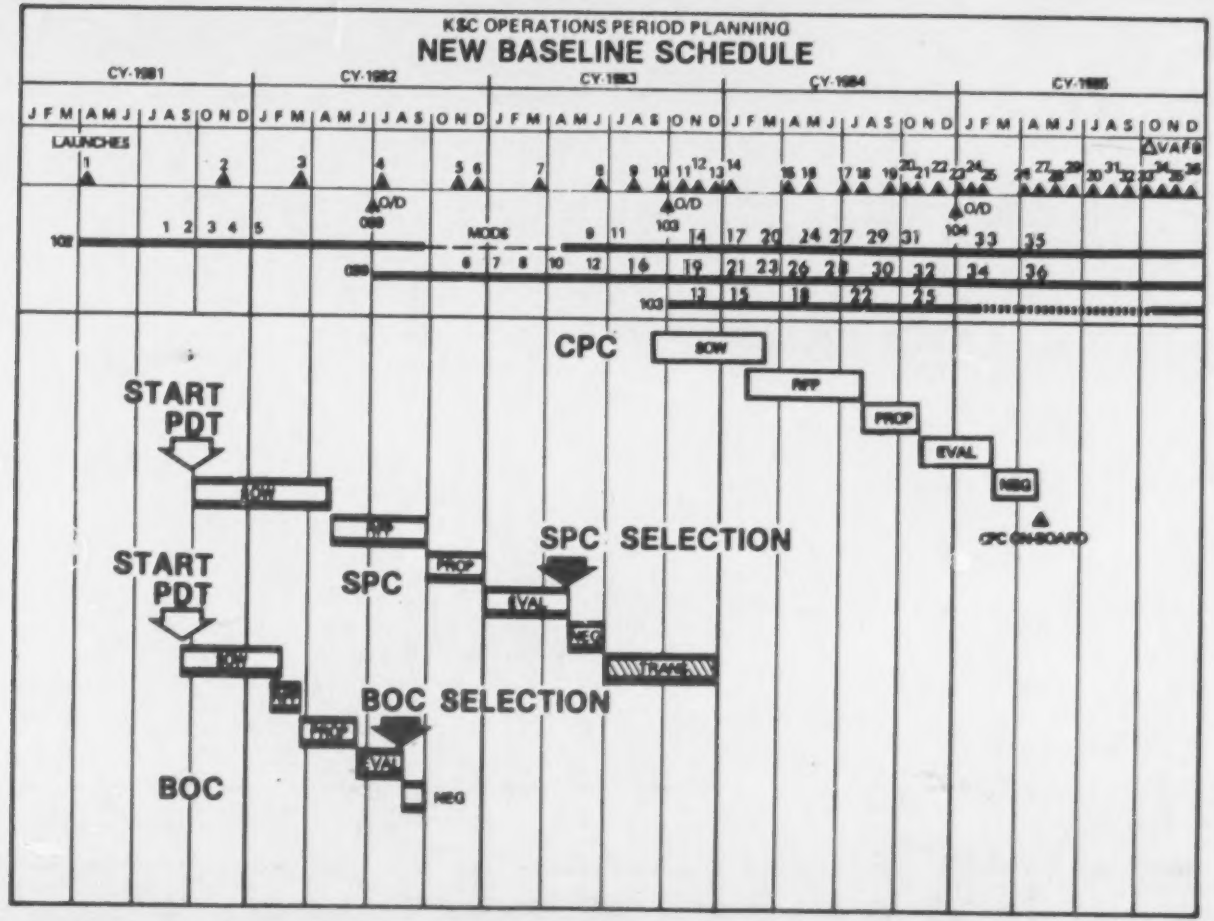
K&C OPERATIONS PERIOD PLANNING
NEW BASELINE SCHEDULE
CY-1981
CY-1982
CY-1983
CY-1984
CY-1985
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
LAUNCHES
VAFB
C/D
MODS
CPC
SOW
RFP
PROP
EVAL
NEG
CPC ON-BOARD
START PDT
SPC SELECTION
SPC
START PDT
BOC SELECTION
BOC
NEG

Figure 3

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

AGENDA

- KSC SHUTTLE PROGRAM PRIORITIES AND PLANNING
- STS-3 THROUGH STS-8 PLANNING
- PROJECTED LAUNCH RATE CAPABILITIES

KSC FORM 10-95 (REV 6/77)

Figure 4

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

KSC SHUTTLE PROGRAM PRIORITIES:

- SAFE AND SUCCESSFUL LAUNCH OPERATIONS
- REDUCE LAUNCH OPERATIONS COSTS
- MAINTAIN LAUNCH SCHEDULE
- COMPLETE KSC FACILITIES
- IMPROVE TURNAROUND EFFICIENCY
- SUPPORT DEVELOPMENT OF VAFB FACILITIES

KSC FORM 10-95 (REV 6/77)

Figure 5

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

OPERATIONS PLANNING:

0 32 FLIGHTS THROUGH FY'85

FY	81	82	83	84	85	86	87	88	MAX RATE
TOTAL	1	3	5	10	14	16	21	24	24
KSC	1	3	5	10	13	15	15	18	18

0 4 ORBITER FLEET

OV-099 . . . . . JUNE 30, 1982
OV-103 . . . . . SEPT. 30, 1983
OV-104 . . . . . DEC. 31, 1984

0 FIRST OPERATIONS FLIGHT (STS-5) ON NOVEMBER 11, 1982

KSC FORM 10-98 (REV 8/77)

Figure 6

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

FACILITIES AND GROUND SYSTEMS CAPABILITIES TO BE PROVIDED:

ORBITER PRODUCTION FACILITY, BAY 2 (OPF-2)	JUNE 30, 1982
MOBILE LAUNCH PLATFORM-2 (MLP-2)	SEPT. 30, 1982
FIRING ROOM-3 (FR-3)	DEC. 31, 1982
VEHICLE ASSEMBLY BUILDING, HIGH BAY-1 & 2 (VAB HB-1 & 2)	JUNE 30, 1983
SOFTWARE PRODUCTION FACILITY	OCT. 30, 1983
SOLID ROCKET MOTOR (SRM) PROCESSING FACILITY	JAN. 31, 1984
MOBILE LAUNCH PLATFORM-3 (MLP-3)	SEPT. 30, 1986
PAD B	SEPT. 30, 1986

KSC FORM 10-98 (REV 6/77)

Figure 7

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-3 THROUGH STS-8 PLANNING:

- REVIEW EACH FLOW
  - PLANS
  - MILESTONES
- SUMMARY

KSC FORM 10-22 (REV. 8/77)

Figure 8

STS-3 PLANS AND STATUS:

- OMS/RCS PODS/FRCS NOT REMOVED
- CRYO TANKING TEST REQUIRED
- DRY CDDT REQUIRED
- CRITICAL PATH WORKED 6 DAYS/WEEK, 3 SHIFTS/DAY
- MODS WORKED 7 DAYS/WEEK, 3 SHIFTS/DAY

KSC FORM 10-93 (REV 8/77)

Figure 9

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-3 MILESTONE DATES:

0	ORBITER RETURNED TO KSC	11/26/81
0	SRB STACKING START	11/23/81
0	SRB STACKING COMPLETE	12/9/81
0	ET ARRIVAL	10/4/81
0	ET MATE TO SRB	1/4/82
0	ORBITER ROLLOUT FROM OPF	2/3/82
0	VAB ROLLOUT	2/19/82
0	LAUNCH	3/22/82
0	RETURN TO KSC	4/9/82

STS-3 ORBITER STAY TIMES		WORKDAYS	CALENDAR DAYS
0	OPF	53	70
0	VAB	15	16
0	PAD	28	32

KSC FORM 10-99 (REV 6/77)

Figure 10

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-3 ACTIVITES:

- 94 MODS REQUIRED, 89 COMPLETED (COMPARED TO 116 MODS FOR STS-2), 5 MODS DEFERRED TO VAB/PAD
- 471 TILES REMOVED AND REPLACED
- FUEL CELLS REMOVED AND REPLACED
- FOURTH CRYO TANK SET ADDED
- #1 APU REMOVED AND REPLACED
- OSS PAYLOAD INSTALLED; GET-AWAY SPECIAL INSTALLED

KSC FORM 10-88 (REV 6/77)

Figure 11

MAJOR STS-3 ACTIVITIES COMPLETED:

0	ORBITER ARRIVAL AT OPF	Nov. 26, 1981
0	POST-FLIGHT TROUBLESHOOTING	Dec. 3 - 7, 1981
0	POWER DOWN MOD PERIOD	Dec. 8 - 15, 1981
0	REMOVE STS-2 P/L (OSTA-1) AND RECONFIGURE P/L BAY	Dec. 5 - 22, 1981
0	POWER UP MOD PERIOD	Dec. 16 - Jan. 18, 1982
0	POWER UP TEST OPERATIONS	Dec. 16 - Jan. 23, 1982
0	ORBITER/PAYLOAD BAY ELECT INTERFACE SYSTEM VERIFICATION	Jan. 4 - 6, 1982
0	INSTALL OSS-1 CARGO	Jan. 10, 1982
0	CARGO INTERFACE VERIFICATION	Jan. 26, 1982
0	POCC/MCCH INTERFACE TEST	Jan. 27, 1982
0	TPS WATERPROOFING	Jan. 21 - Feb. 2, 1982
0	WEIGHT & CG DETERMINATION	Feb. 2, 1982
0	ROLLOUT	Feb. 3, 1982

KSC FORM 10-93 (REV 6/77)

Figure 12

MAJOR STS-3 ACTIVITIES REMAINING TO BE DONE:

VAB:

- ORBITER/ET UMBILICAL MATE . . . . . FEB. 5 - 9, 1982
- SHUTTLE INTERFACE TEST. . . . . FEB. 8 - 16, 1982
- TRANSFER TO PAD PREPS . . . . . FEB. 17 - 18, 1982
- TRANSFER TO PAD . . . . . FEB. 19, 1982

PAD:

- SHUTTLE LAUNCH PAD VALIDATION . . . . . FEB. 21 - 23, 1982
- DRY CDDT. . . . . FEB. 24 - 26, 1982
- INTEGRATED CRYO LOAD. . . . . FEB. 27 - MAR. 3, 1982
- PRELAUNCH PROPELLANT LOAD PREPS . . . . . MAR. 2 - 6, 1982
- HYPERGOL LOADING. . . . . MAR. 7 - 10, 1982
- COUNTDOWN PREPS . . . . . MAR. 11 - 17, 1982
- COUNTDOWN . . . . . MAR 18 - 22, 1982
- LAUNCH. . . . . MAR. 22, 1982

Figure 13

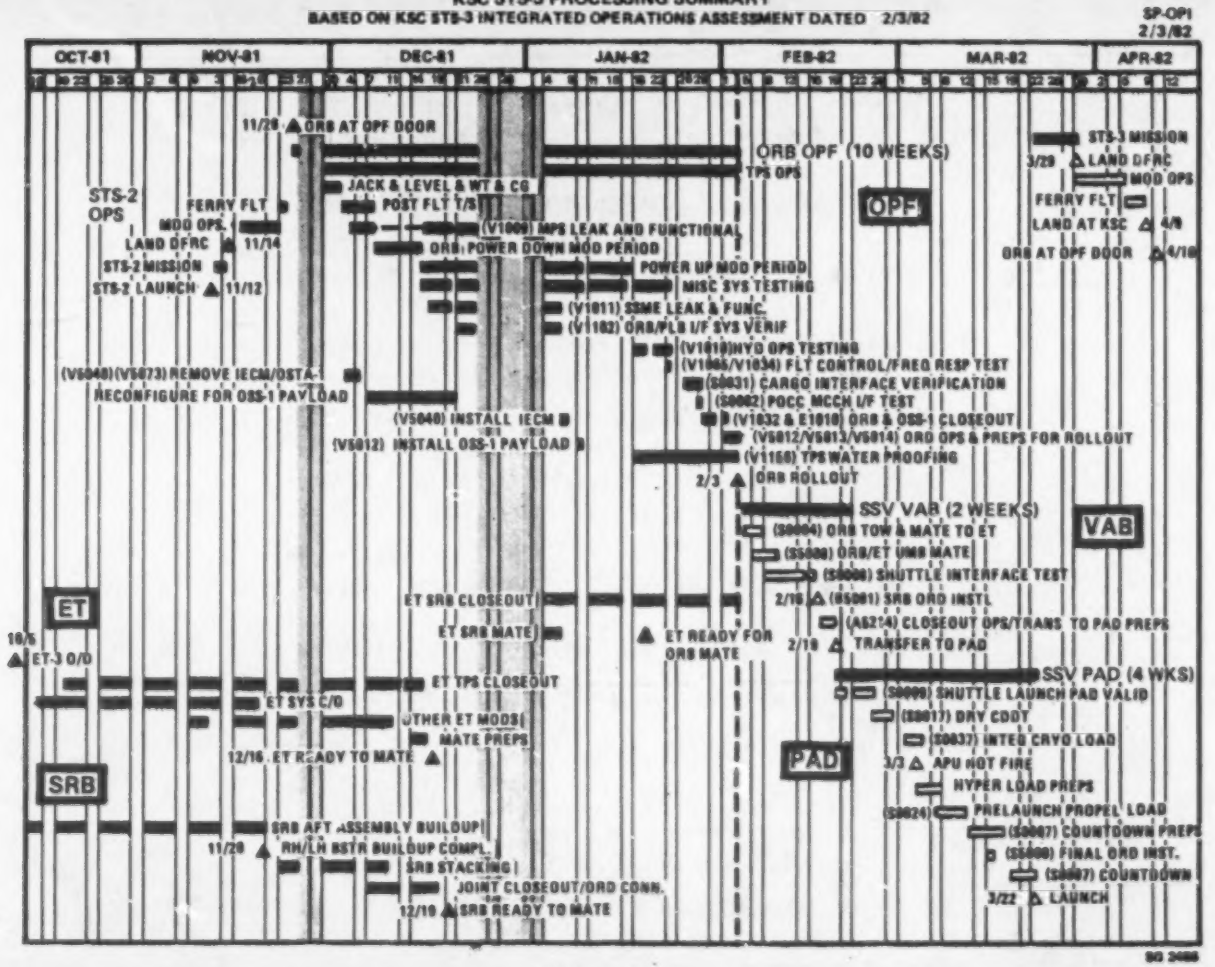
KSC STS-3 PROCESSING SUMMARY
BASED ON KSC STS-3 INTEGRATED OPERATIONS ASSESSMENT DATED 2/3/82
SP-OP1
2/3/82
OCT-81
NOV-81
DEC-81
JAN-82
FEB-82
MAR-82
APR-82
11/20 ORB AT OPF DOOR
ORB OPF (10 WEEKS)
TPS OPS
JACK & LEVEL & WT & CG
POST FLT T/S
STS-2 OPS
FERRY FLT
MOD OPS.
LAND DFRC
11/14
STS-2 MISSION
STS-2 LAUNCH
11/12
(V1009) MPS LEAK AND FUNCTIONAL
ORB POWER DOWN MOD PERIOD
POWER UP MOD PERIOD
MISC SYS TESTING
(V1011) SSME LEAK & FUNC.
(V1102) ORB/PLB I/F SYS VERIF
OPF
STS-3 MISSION
3/29 LAND DFRC
MOD OPS
FERRY FLT
LAND AT KSC 4/9
ORB AT OPF DOOR 4/10
(V1010)HYD OPS TESTING
(V1005/V1034) FLT CONTROL/FREQ RESP TEST
(S0031) CARGO INTERFACE VERIFICATION
(S0002) POCC MCCH I/F TEST
(V1032 & E1010) ORB & OSS-1 CLOSEOUT
(V5012/V5013/V5014) ORD OPS & PREPS FOR ROLLOUT
(V1150) TPS WATER PROOFING
2/3 ORB ROLLOUT
(V5048)(V5073) REMOVE IECM/OSTA
RECONFIGURE FOR OSS-1 PAYLOAD
(V5048) INSTALL IECM
(V5012) INSTALL OSS-1 PAYLOAD
SSV VAR (2 WEEKS)
(S0004) ORB TOW & MATE TO ET
(S5008) ORB/ET UMB MATE
(S5008) SHUTTLE INTERFACE TEST
VAB
ET
ET SRB CLOSEOUT
2/16 (S5001) SRB ORD INSTL
(A5214) CLOSEOUT OPS/TRANS TO PAD PREPS
ET SRB MATE
ET READY FOR ORB MATE
2/19 TRANSFER TO PAD
10/5 ET-3 O/D
ET TPS CLOSEOUT
SSV PAD (4 WKS)
(S0009) SHUTTLE LAUNCH PAD VALID
ET SYS C/O
(S0017) DRY CDDT
OTHER ET MODS
(S0037) INTEG CRYO LOAD
MATE PREPS
12/16 ET READY TO MATE
PAD
3/3 APU HOT FIRE
SRB
HYPER LOAD PREPS
(S0024) PRELAUNCH PROPEL LOAD
SRB AFT ASSEMBLY BUILDUP
(S0007) COUNTDOWN PREPS
11/20 RH/LH BSTR BUILDUP COMPL
(S5008) FINAL ORD INST.
SRB STACKING
(S0007) COUNTDOWN
JOINT CLOSEOUT/ORD CONN.
3/22 LAUNCH
12/19 SRB READY TO MATE
SO 3488

Figure 14

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-3 RETRIEVAL SYSTEM EVENTS/ACTIVITIES:

- 0 RETRIEVAL VESSELS HAVE HAD FIRST SCHEDULED DRY DOCK PERIOD
  - RE-CERTIFIED BY COAST GUARD
- 0 SRB TOW LOADS UNDER HEAVY SEAS ARE NEAR UPPER LIMITS BREAKING WEAK-LINK
  - UPPER LIMITS BEING INCREASED TO 47K (FROM 40K)
  - WEAK-LINK BEING MODIFIED
- 0 DEWATER SYSTEM (BARB) BEING MODIFIED TO CORRECT MINOR PROBLEMS
  - STRENGTHEN MAIN SUPPORTS
  - INCREASE AIR HOSE DIAMETER TO PROVIDE MORE AIR FLOW
- 0 SRM NOZZLE SEVERANCE SYSTEM CABLES FAILED ON STS-2 CAUSING LOSS OF NOZZLE
  - BEING STRENGTHENED TO PREVENT REOCCURRENCE
- 0 AFT SKIRT INTERNAL STIFFENING RINGS BEING DAMAGED AT WATER IMPACT
  - BEING MODIFIED TO REDUCE LOADS UNTIL PERMANENT STRUCTURES FIX INCORPORATED

KSC FORM 10-88 (REV 8/77)

Figure 15

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

- STS-4 PLANS
  - NO POWER DOWN MOD PERIOD
    - 22 POWER UP MODS - 17 DAYS
  - NO DRY CDDT
  - CRYO TANKING TEST PLANNED
  - LAND AT DFRC

- MILESTONES

OPF OPERATIONS	35 WORKDAYS	ROLLOUT	5/20/82
VAB OPERATIONS	13 WORKDAYS	ROLLOUT	6/3/82
PAD OPERATIONS	28 WORKDAYS	LAUNCH	7/4/82
DFRC OPERATIONS	11 WORKDAYS	LANDING	7/11/82
ORBITER BACK AT KSC			7/23/82

- CONCERNS
  - DOD SECURITY REQUIREMENTS

Figure 16

KSC FORM 10-93 (REV 9/77)

STS-4 PROCESSING SUMMARY

BASED ON STS-4 INTEGRATED OPERATIONS ASSESSMENT DATED JAN. 11, 1982

SP-OP1
1/29/82

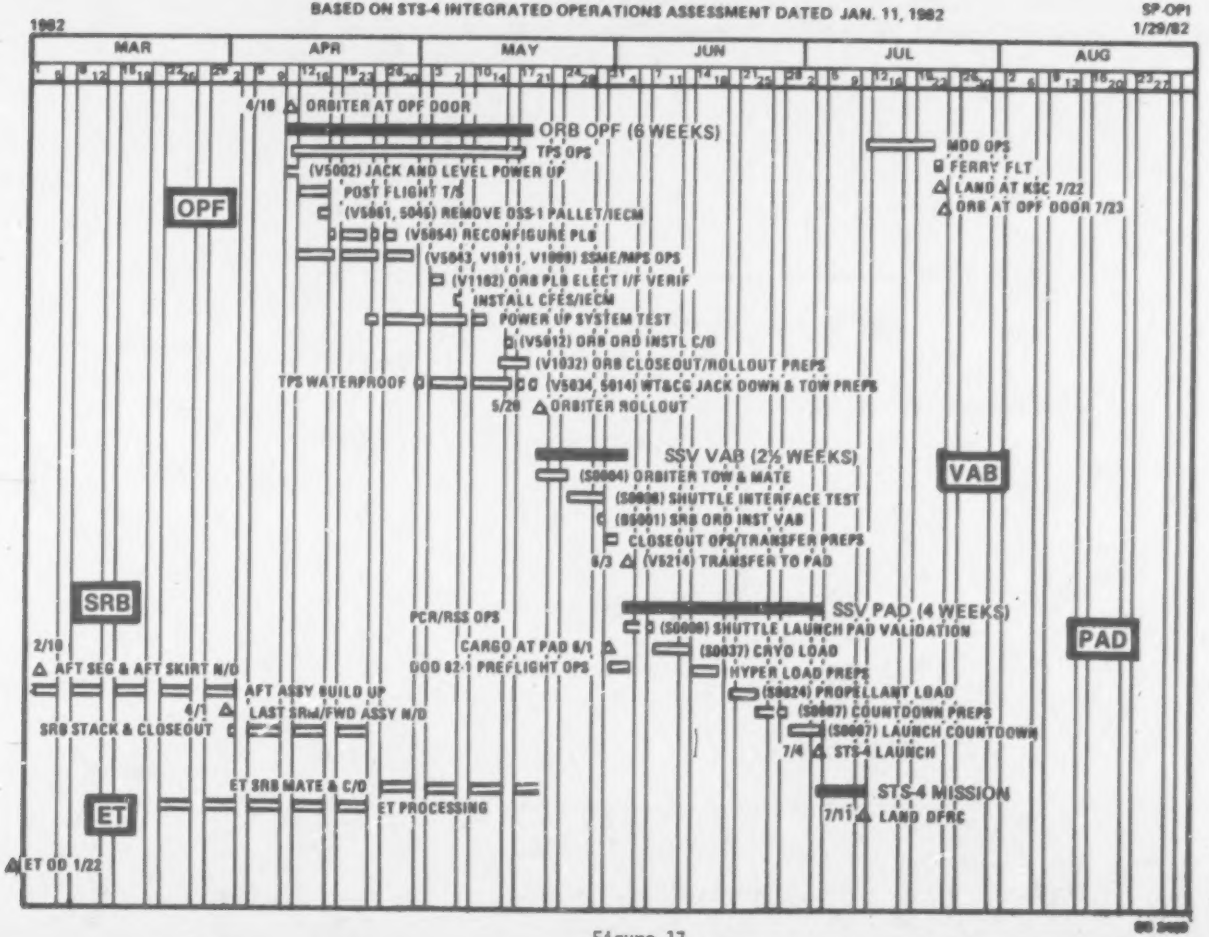

Figure 17

- STS-5 PLANS
  - 28 WORK DAYS POWERED DOWN OPF MOD PERIOD
  - PARALLEL OPERATIONS WITH STS-6 (OV-099)
  - LAND AT KSC
  - POST FLIGHT OPS
    - OMS PODS - SSME's REMOVED AND STORED AT KSC
    - FRCS REMOVED, DECONTAMINATED, REINSTALLED
    - COLUMBIA FERRY TO DFRC - THEN TO PALMDALE FOR 6 MONTHS MOD PERIOD

- MILESTONES

OPF OPERATIONS	61 WORKDAYS	ROLLOUT	10/1/82
VAB OPERATIONS	15 WORKDAYS	ROLLOUT	1/18/82
PAD OPERATIONS	23 WORKDAYS	LAUNCH	11/11/82
KSC LANDING	MISSION-5 DAYS	LANDING	11/16/82
PREP FOR SHIPPING OPS	17 WORKDAYS	SHIP	12/6/82
PALMDALE	136 WORKDAYS	SHIP	6/20/83
ORBITER BACK AT KSC			6/25/83

Figure 18

KSC STS-5 PROCESSING SUMMARY

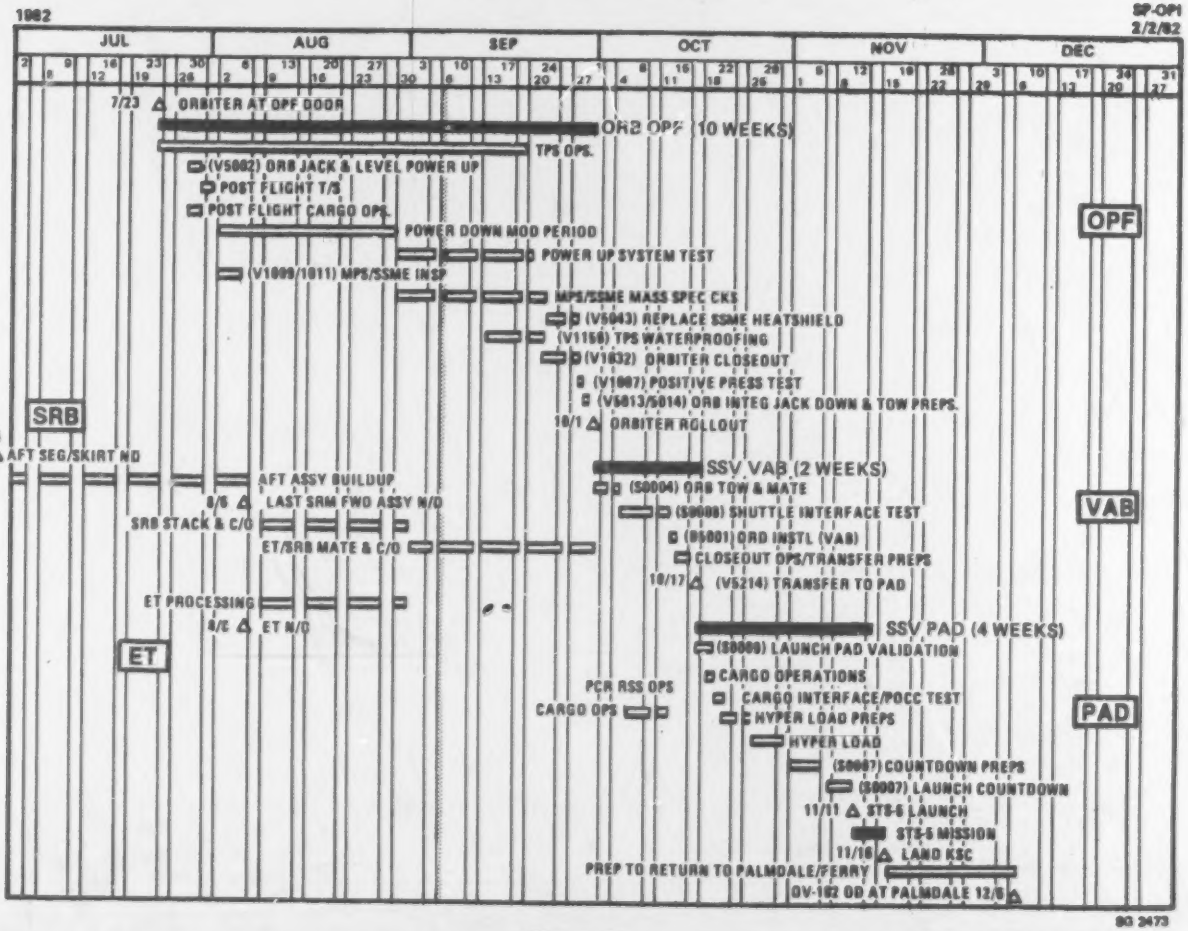

Figure 19

STS-6:

- PLANS
  - FIRST FLIGHT OF OV-099 (ON DOCK JUNE 30, 1982)
  - FIRST FLIGHT LIGHTWEIGHT ET
  - FIRST FLIGHT LIGHTWEIGHT SRB's
  - FIRST TDRS; IUS/TDRS WEIGHS 46,700 LBS.
  - REQUIRES SPECIAL DYNAMIC STABILITY TEST
    - IUS CRADLE AND PATHFINDER IUS USED
  - CRYO LOAD TEST PLANNED
  - OPF ACTIVITIES IN PARALLEL WITH OV-102
  - CERTAIN SECOND LINE OF FACILITIES REQUIRED:

    OPF BAY 2 . . . . . 6/30/82
    CONTROL ROOM 2. . . . . 6/30/82
    MLP-2 . . . . . 8/30/82

  - TRANSFERRED WORK
    - SSME INSTALLATION
    - OMS PODS CHECK OUT AND INSTALLATION
    - OTHER SCHEDULED MODS
  - LANDS AT KSC

KSC FORM 10-88 (REV 6/77)

Figure 20

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

STS-6:

MILESTONES:

OPF OPERATIONS	78 WORKDAYS	ROLLOUT	11/15/82
VAB OPERATIONS	15 WORKDAYS	ROLLOUT	12/9/82
PAD OPERATIONS	29 WORKDAYS	LAUNCH	1/20/83
ORBITER AT OPF	3 WORKDAYS		1/23/83

CONCERNS:

- FIRST FLOW OF OV-099
- FIRST USE OF CERTAIN FACILITIES (OPF-2, FR-2, MLP-2)
- FIRST TWO-IN-FLOW
- SLIPS IN STS-3, -4, -5 MAY AFFECT STS-6 SCHEDULE

KSC FORM 10-98 (REV. 6/77)

Figure 21

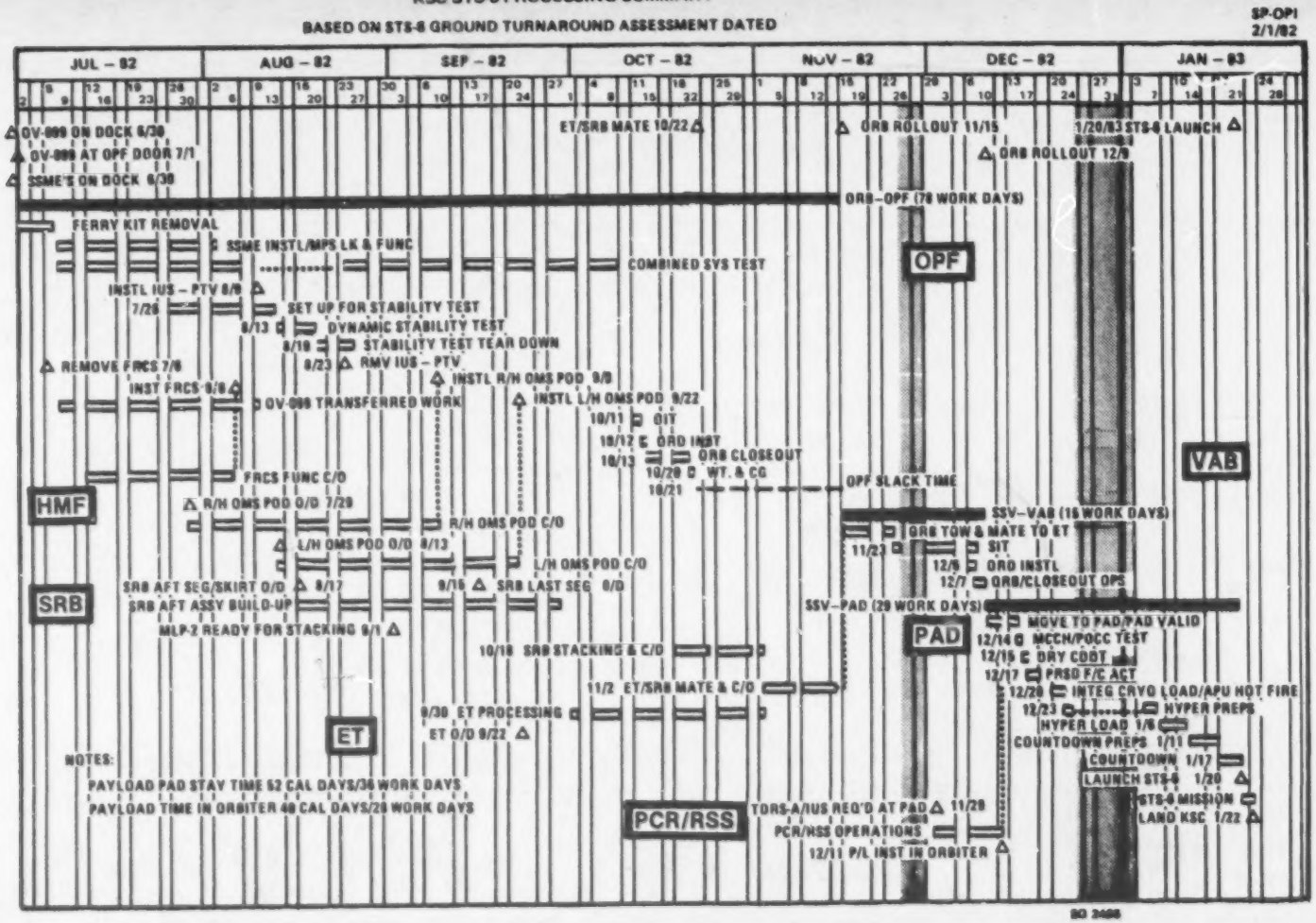
KSC STS-6 PROCESSING SUMMARY
BASED ON STS-6 GROUND TURNAROUND ASSESSMENT DATED
SP-OPI
2/1/82
JUL – 82
AUG – 82
SEP – 82
OCT – 82
NOV – 82
DEC – 82
JAN – 83
OV-099 ON DOCK 6/30
OV-099 AT OPF DOOR 7/1
SSME'S ON DOCK 6/30
ET/SRB MATE 10/22
ORB ROLLOUT 11/15
ORB ROLLOUT 12/9
1/20/83 STS-6 LAUNCH
ORB–OPF (78 WORK DAYS)
FERRY KIT REMOVAL
SSME INSTL/MPS LK & FUNC
COMBINED SYS TEST
OPF
INSTL IUS – PTV 8/8
7/26
SET UP FOR STABILITY TEST
8/13
DYNAMIC STABILITY TEST
8/19
STABILITY TEST TEAR DOWN
8/22
RMV IUS – PTV
REMOVE FRCS 7/8
INSTL R/H OMS POD 9/8
INST FRCS 8/8
OV-099 TRANSFERRED WORK
INSTL L/H OMS POD 9/22
10/11
OIT
10/12
ORD INST
10/13
ORB CLOSEOUT
10/20
WT. & CG
10/21
OPF SLACK TIME
VAB
FRCS FUNC C/O
HMF
R/H OMS POD O/D 7/29
R/H OMS POD C/O
SSV–VAB (15 WORK DAYS)
ORB TOW & MATE TO ET
11/23
SIT
12/6
ORD INSTL
12/7
ORB/CLOSEOUT OPS
L/H OMS POD O/D 8/13
L/H OMS POD C/O
SRB AFT SEG/SKIRT O/D 8/17
9/16
SRB LAST SEG 8/D
SRB
SRB AFT ASSY BUILD-UP
SSV–PAD (29 WORK DAYS)
MLP-2 READY FOR STACKING 9/1
MOVE TO PAD/PAD VALID
12/14
MCCH/POCC TEST
PAD
10/18 SRB STACKING & C/D
12/15
DRY COOT
12/17
PRSD F/C ACT
11/2 ET/SRB MATE & C/O
12/20
INTEG CRYO LOAD/APU HOT FIRE
12/23
HYPER PREPS
9/30 ET PROCESSING
ET O/D 9/22
ET
HYPER LOAD 1/6
COUNTDOWN PREPS 1/11
COUNTDOWN 1/17
LAUNCH STS-6 1/20
NOTES:
PAYLOAD PAD STAY TIME 52 CAL DAYS/36 WORK DAYS
PAYLOAD TIME IN ORBITER 40 CAL DAYS/28 WORK DAYS
STS-6 MISSION
LAND KSC 1/22
TDRS-A/IUS REQ'D AT PAD 11/28
PCR/RSS
PCR/RSS OPERATIONS
12/11 P/L INST IN ORBITER
SO 2488

Figure 22

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

- STS-7 PLANS
  - NO POWER DOWN MODS
  - PODS NOT REMOVED
  - NO DRY CDDT - NO CRYO LOAD
- MILESTONES

OPF OPERATIONS	41 WORKDAYS	ROLLOUT	3/11/83
VAB OPERATIONS	13 WORKDAYS	ROLLOUT	3/26/83
PAD OPERATIONS	23 WORKDAYS	LAUNCH	4/20/83
ORBITER AT OPF	6 WORKDAYS		4/26/83

KSC FORM 18-88 (REV 8/77)

Figure 23

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-8:

0 PLANS
- o MINIMUM TESTING
- o STABLE TURNAROUND
- o NO MODS
- o MINIMUM TPS REWORK

0 MILESTONES

OPF OPERATIONS	28 WORKDAYS	ROLLOVER	5/27/83
VAB OPERATIONS	12 WORKDAYS	ROLLOUT	6/13/83
PAD OPERATIONS	19 WORKDAYS	LAUNCH	7/4/83
ORBITER AT OPF	4 DAYS		7/8/83

Figure 24

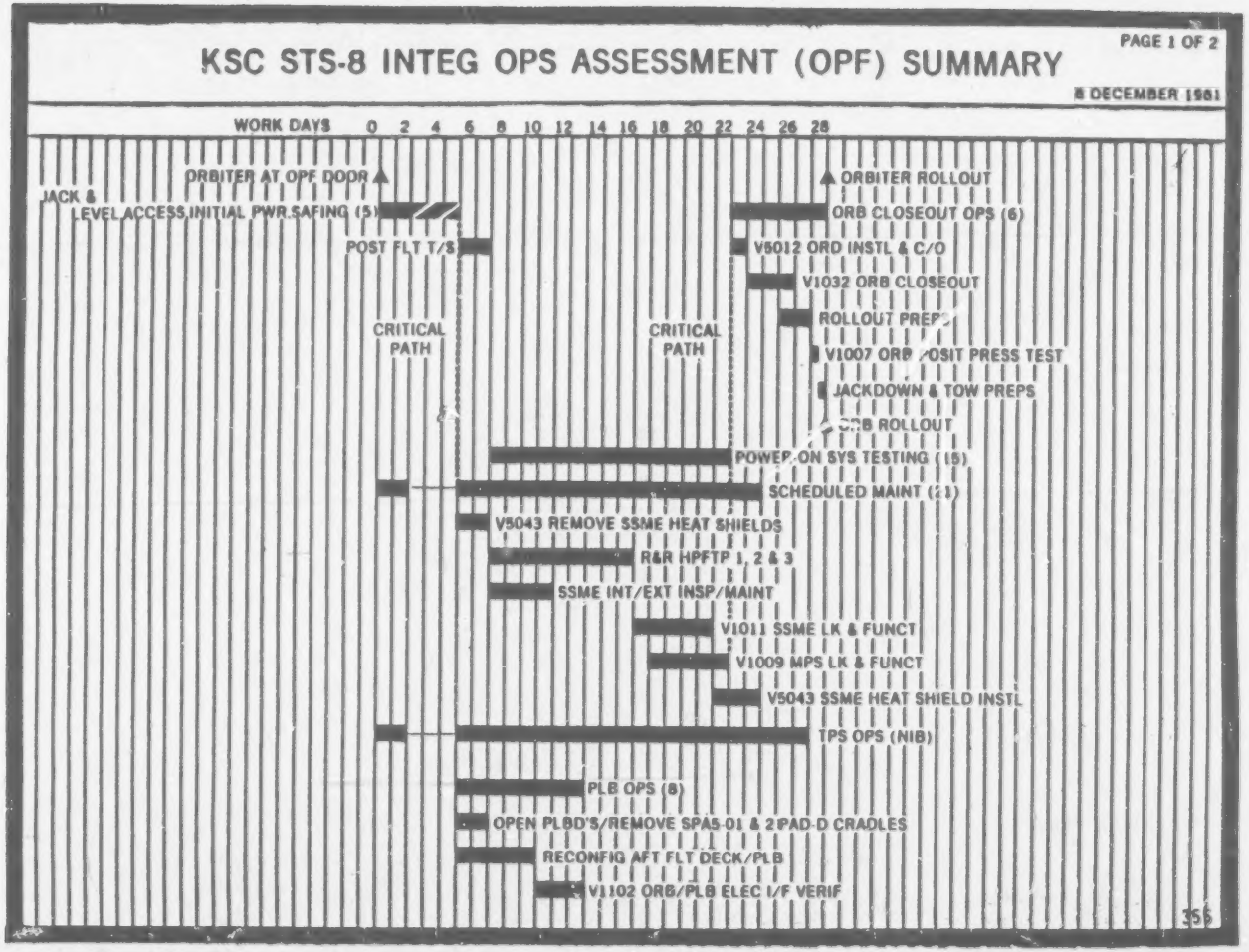
KSC STS-8 INTEG OPS ASSESSMENT (OPF) SUMMARY
PAGE 1 OF 2
8 DECEMBER 1981
WORK DAYS 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
ORBITER AT OPF DOOR
ORBITER ROLLOUT
JACK & LEVEL ACCESS, INITIAL PWR SAFING (5)
ORB CLOSEOUT OPS (6)
POST FLT T/S
V5012 ORD INSTL & C/O
V1032 ORB CLOSEOUT
ROLLOUT PREPS
CRITICAL PATH
CRITICAL PATH
V1007 ORB POSIT PRESS TEST
JACKDOWN & TOW PREPS
ORB ROLLOUT
POWER-ON SYS TESTING (15)
SCHEDULED MAINT (21)
V5043 REMOVE SSME HEAT SHIELDS
R&R HPFTP 1, 2 & 3
SSME INT/EXT INSP/MAINT
V1011 SSME LK & FUNCT
V1009 MPS LK & FUNCT
V5043 SSME HEAT SHIELD INSTL
TPS OPS (NIB)
PLB OPS (8)
OPEN PLBD'S/REMOVE SPAS-01 & 2 PAD-D CRADLES
RECONFIG AFT FLT DECK/PLB
V1102 ORB/PLB ELEC I/F VERIF
356

Figure 25

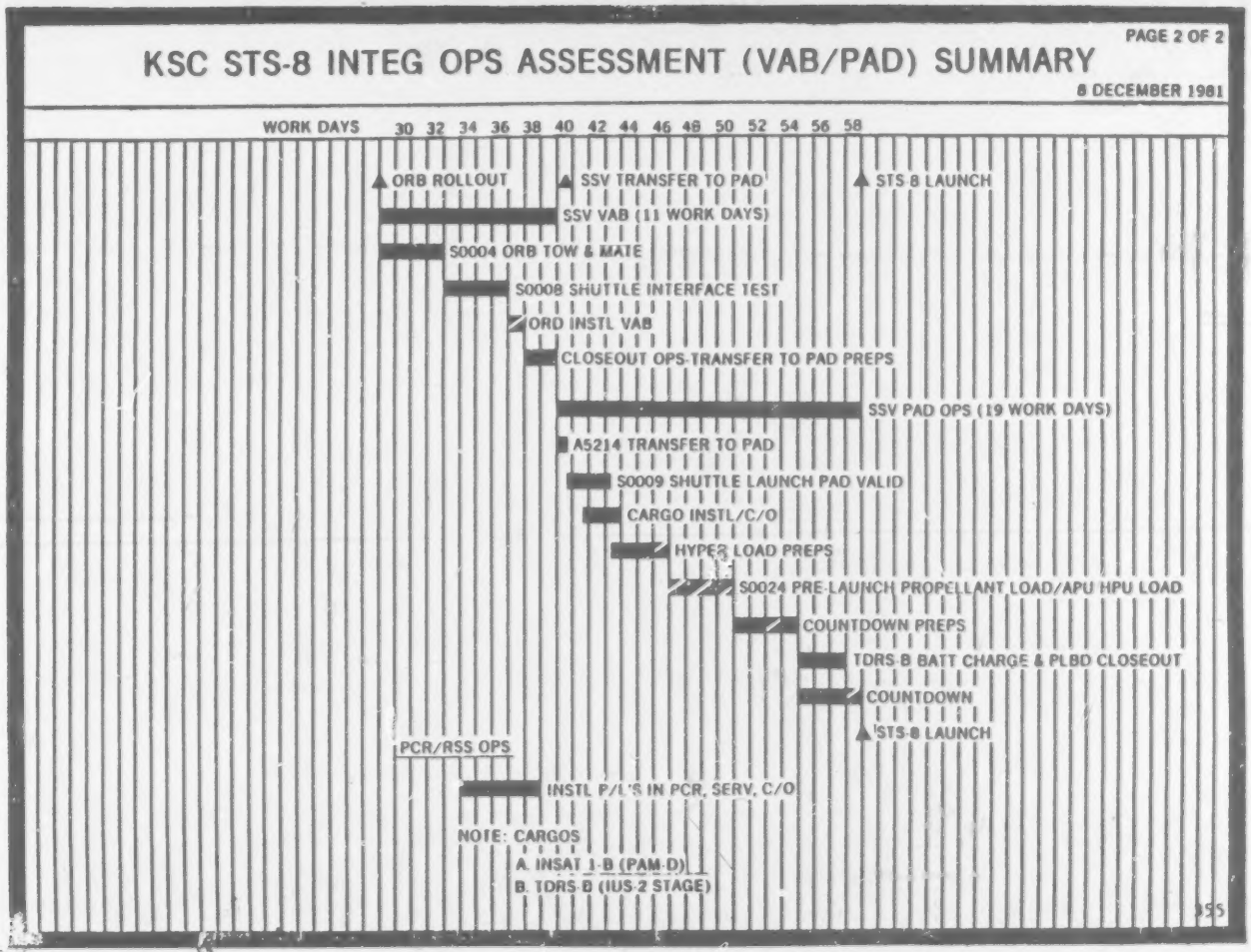
KSC STS-8 INTEG OPS ASSESSMENT (VAB/PAD) SUMMARY
8 DECEMBER 1981
WORK DAYS 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58
ORB ROLLOUT
SSV TRANSFER TO PAD
STS-8 LAUNCH
SSV VAB (11 WORK DAYS)
S0004 ORB TOW & MATE
S0008 SHUTTLE INTERFACE TEST
ORD INSTL VAB
CLOSEOUT OPS-TRANSFER TO PAD PREPS
SSV PAD OPS (19 WORK DAYS)
A5214 TRANSFER TO PAD
S0009 SHUTTLE LAUNCH PAD VALID
CARGO INSTL/C/O
HYPER LOAD PREPS
S0024 PRE-LAUNCH PROPELLANT LOAD/APU HPU LOAD
COUNTDOWN PREPS
TDRS-B BATT CHARGE & PLBD CLOSEOUT
COUNTDOWN
STS-8 LAUNCH
PCR/RSS OPS
INSTL P/L'S IN PCR, SERV, C/O
NOTE: CARGOS
A. INSAT 1-B (PAM-D)
B. TDRS-B (IUS-2 STAGE)
355

Figure 26

93-418 O—82—5

KSC SPACE TRANSPORTATION SYSTEM PROJECTS	HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS	R. H. GRAY FEBRUARY 5, 1982

STS-3 THROUGH STS-8 SUMMARY:

0 STS-3	MARCH 22, 1982
0 STS-4	JULY 4, 1982
0 STS-5	NOVEMBER 11, 1982
0 STS-6	JANUARY 20, 1983
0 STS-7	APRIL 20, 1983
0 STS-8	JULY 4, 1983

KSC FORM 10-98 (REV 6/77)

Figure 27

STS 3 THRU 8 PROCESSING PLANNING SUMMARY

BASED ON JSC 17379 (FDRD) REV. B DATED 1/20/82

SP-OPI
2/5/82

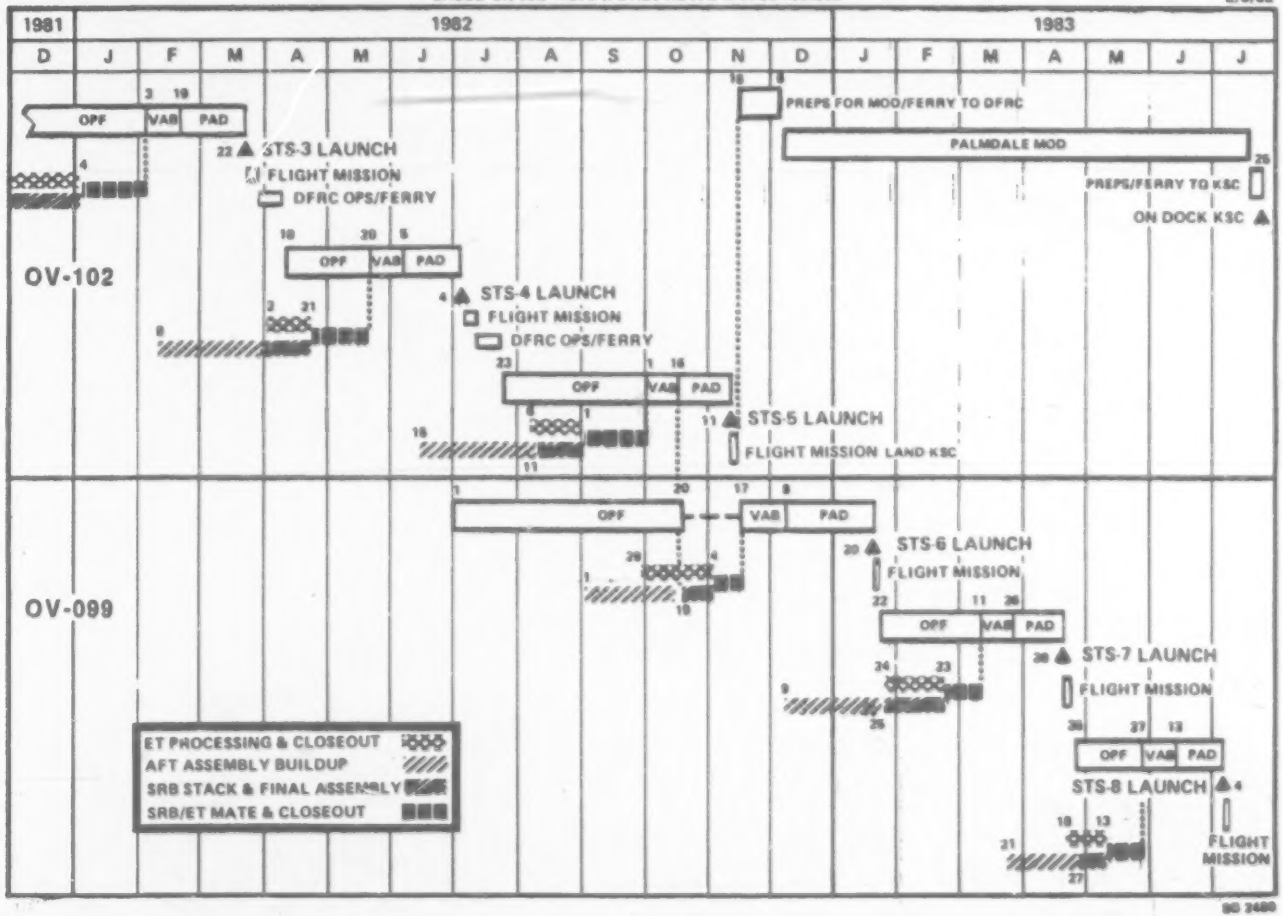

Figure 28

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEB. 5, 1982

STS TURNAROUND COMPARISON SUMMARY
TIME IN WORK DAYS

FLT #	ORBITER	OPF	VAB	PAD	MISSION	DFRC	KSC	ALL
STS-1	102	210/610*	25/32*	80/102*	2/2*	10/15*	315/744*	327/761*
STS-2	102	89/99*	19/19*	29/70*	5/2*	10/12*	137/188*	152/202*
STS-3	102	55/53*	15	28	7	12	98	117
STS-4	102	35	13	28	7	12	76	95
STS-5	102	61	15	23	5	0	99	104
STS-6	099	78	15	29	2	0	122	124
STS-7	099	41	13	23	5	0	77	82
STS-8	099	28	12	19	3	0	59	62

*ACTUAL TIME

KSC FORM 10-95 (REV. 6/77)

Figure 29

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

TRAFFIC MODEL REQUIREMENTS

FISCAL YEAR	83	84	85	86	87	88	89	90
FLIGHT RATE (KSC)	5	10	13	15	15	18	19	18
VAFB FLIGHT RATE			1	1	6	6	5	6

KSC FORM 10-95 (REV 6/77)

Figure 30

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

CURRENT STS-8 ORBITER TURNAROUND PLAN (BASELINE)	WORKDAYS
0 OPF	28
0 VAB	12
0 PAD	19
	59 TOTAL
OTHER CRITICAL PATH OPERATIONS	
0 PAD REFURB	6
0 MLP REFURB	6
0 SRB AFT SKIRT B/U	12
0 SRB/ET STACK	20
MLP UTILIZATION TIME	
0 REFURBISHMENT	6
0 VAB STACKING OEPRATIONS	20
0 VAB INTEGRATED OPERATIONS	12
0 PAD OPERATIONS	19
	57 TOTAL

KSC FORM 10-93 (REV 6/77)

Figure 31

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

- MAXIMUM FLIGHT RATE CAPABILITY WITH BASELINE TURNAROUND PLAN (STS-8)
  59 WORKING DAYS

(1985-1986) 3 ORBITERS	PAD A MLP 1/2	PAD A MLP 1/2/3	PAD A/B MLP 1/2/3
	10	11	14

- SHIFTING BASED ON 6/3

KSC FORM 10-88 (REV 6/77)

Figure 32

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

STS-8 BASELINE PLUS IMPROVEMENTS/ENHANCEMENTS

IMPROVE OPERATIONS

- DELETE TESTING
- PARALLEL ACTIVITIES
- STREAMLINE PROCEDURES AND OPERATIONS
- CHANGE METHODS OF WORK PROCESSING
- CHANGE CONTRACTING SCHEME (SPC)
- USE AUTOMATION TECHNIQUES
  - OPTICAL ALIGNMENT SSME/SRB's
  - WORK CONTROL AND SCHEDULING

REDESIGN GRD/FLT HARDWARE

- FACILITY CHANGES (OPF, PAD)
- REDESIGN SRB HARDWARE THAT CONTRIBUTES TO CRITICAL PATH OPERATIONS (MATING AND CLOSEOUT)
- REDESIGN ET HARDWARE (SAME AS SRB)
- REDESIGN ORBITER SYSTEM FOR MAINTAINABILITY AND OPERATIONS SIMPLIFICATION
  - HYPERGOLIC SYSTEMS (OMS/RCS/APU)
  - PAYLOAD BAY DOORS

KSC FORM 16-98 (REV 6/79)

Figure 33

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

- PAD, MLP AND ORBITER PROJECTED RATE CAPABILITY
  - PAD

STS-2	29P/70A*	
STS-8	25 DAYS	11/YEAR
STS-30 ('85)	18 DAYS	15/YEAR
STS-30 IMPROVED	15 DAYS	17/YEAR

  - MLP

STS-2	100P/146A	
STS-8	57 DAYS	5.2/YEAR
STS-30 ('85)	44 DAYS	6.0/YEAR
STS-30 IMPROVED	35 DAYS	7.5/YEAR

  - ORBITER

STS-2	137P/188A	
STS-8	59 DAYS	5/YEAR
STS-30 ('85)	40 DAYS	6.5/YEAR
STS-30 IMPROVED	30 DAYS	7.5/YEAR

- REQUIREMENT

FY	84	85	86	87	88
	10	13	15	15	18

*P = PLANNED, A = ACTUAL

KSC FORM 10-89 (REV 9/77)

Figure 34

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

		WORKING DAYS	
		STS-8	IMPROVED
0	OPF	28	13
	VAB	12	7
	PAD	19	10
	TOTAL ORBITER	59	30
0	PAD REFURB	6	5
	MLP REFURB	6	4
	SRB AFT SKIRT B/U	12	11
	SRB/ET STACK	20	14
0	MLP UTILIZATION TIME		
	REFURBISHMENT	6	4
	VAB STACKING OPERATIONS	20	14
	VAB INTEGRATED OPERATIONS	12	7
	PAD OPERATIONS	19	10
	TOTAL MLP	57	35

KSC FORM 10-98 (REV 6/77)

Figure 35

KSC SPACE TRANSPORTATION SYSTEM PROJECTS

HOUSE SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

R. H. GRAY

FEBRUARY 5, 1982

63

69

- ADJUSTED FLIGHT RATE CAPABILITY WITH DESIGN IMPROVEMENTS

(1985-1986) 3 ORBITERS	PAD A MLP 1/2	PAD A MLP 1/2/3	PAD A/B MLP 1/2/3
	15	17	20

- SHIFTING BASED ON 6/3

KSC FORM 10-98 (REV. 6/77)

Figure 36

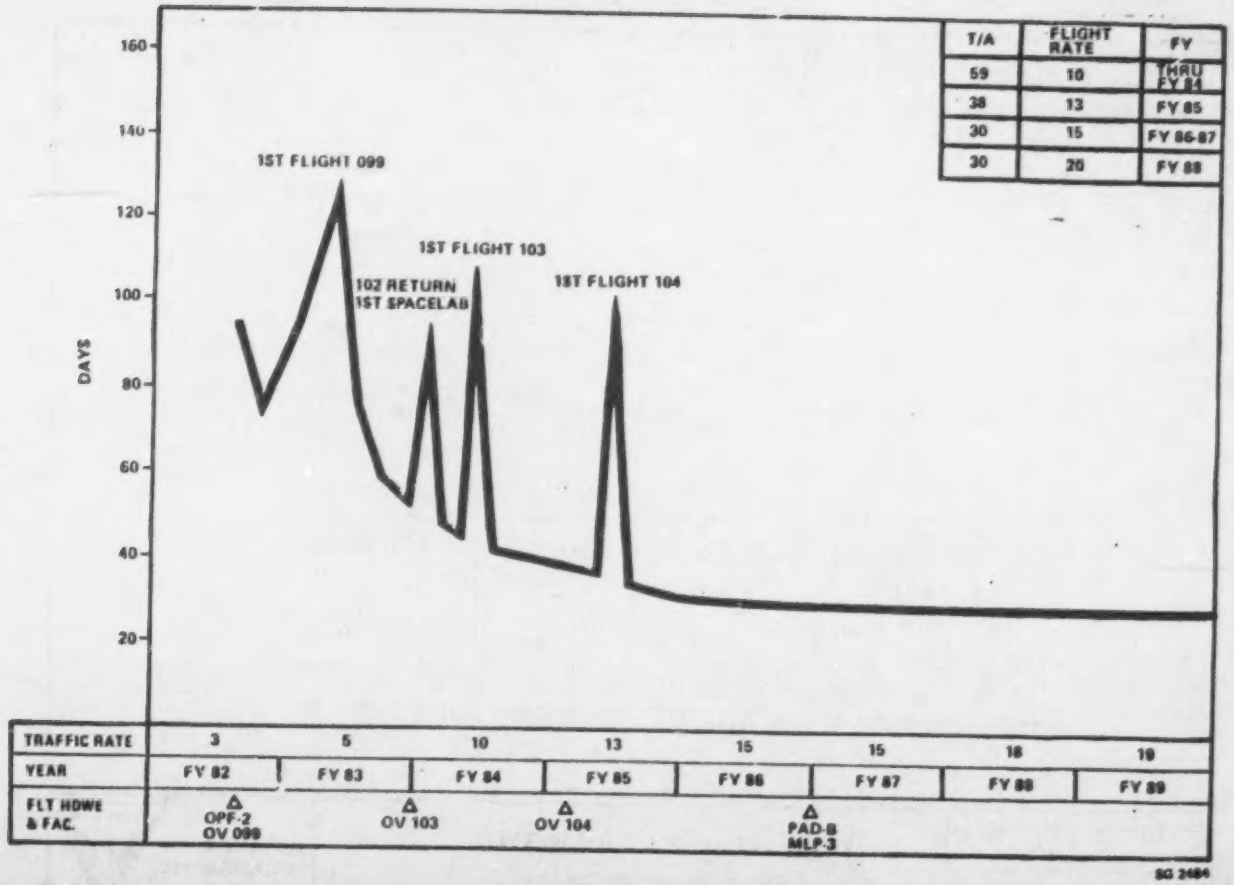
T/A
FLIGHT RATE
FY
59
10
THRU FY 84
38
13
FY 85
30
15
FY 86-87
30
20
FY 88
160
140
120
100
80
60
40
20
DAYS
1ST FLIGHT 099
1ST FLIGHT 103
102 RETURN 1ST SPACELAB
1ST FLIGHT 104
TRAFFIC RATE
3
5
10
13
15
15
18
19
YEAR
FY 82
FY 83
FY 84
FY 85
FY 86
FY 87
FY 88
FY 89
FLT HDWE & FAC.
OPF-2 OV 099
OV 103
OV 104
PAD-B MLP-3
SG 2484

Figure 37

PURPOSE: PRESENT THE KSC OPERATIONS ERA PLANNING STATUS

AGENDA

- BACKGROUND
- CURRENT ACTIVITIES
- SCHEDULE

Figure 38

February 5, 1982

BACKGROUND

- AEROSPACE STUDY (1976)
- NATIONAL ACADEMY OF PUBLIC ADMINISTRATION (NAPA STUDY) (1977)
- KSC STS OPERATIONS MANAGEMENT STUDY (BOOZ-ALLEN & HAMILTON) (1976 - 77)
- KSC STS OPERATIONS STUDY (1977 - 78)

68

72

Figure 39

BACKGROUND

- PLANNING BASELINE ESTABLISHED FROM STS OPERATIONS STUDY
  - KSC SHOULD SELECT BY COMPETITIVE MEANS TWO ESSENTIALLY SELF-SUFFICIENT CONTRACTORS FOR THE PROCESSING OF THE STS LAUNCH VEHICLE AND CARGO
  - A THIRD MAJOR CONTRACT FOR BASE SUPPORT SHOULD ALSO BE COMPETED
  - SEVERAL SMALLER CONTRACTS SHOULD BE RETAINED AND MANAGED BY THE GOVERNMENT
  - THE NUMBER OF CIVIL SERVANTS REQUIRED TO MANAGE THE STS DURING MATURE OPERATIONS SHOULD BE CONSIDERABLY REDUCED BELOW THAT NUMBER REQUIRED DURING DDT&E

Figure 40

KSC OPS ERA CONTRACT BASELINE

- SHUTTLE PROCESSING CONTRACTOR (SPC) - RESPONSIBLE FOR KSC SHUTTLE GROUND OPERATIONS ASSOCIATED WITH LAUNCH AND LANDING
- CARGO PROCESSING CONTRACT (CPC) - RESPONSIBLE FOR INTEGRATING SHUTTLE PAYLOADS PRIOR TO INSTALLATION INTO THE ORBITER
- BASE OPERATIONS CONTRACT (BOC) - RESPONSIBLE FOR OPERATING AND SERVICING THE KSC INSTITUTIONAL FUNCTIONS

Figure 41

93-418 O-82---6

BACKGROUND

- FURTHER PLANNING ACTIVITIES
  - CENTER PLANNING LED DEVELOPMENT OF IMPLEMENTATION PLANS
  - ADVOCATE GROUP ESTABLISHED TO AID TOTAL CENTER PARTICIPATION IN PLANS
    - KEY LINE & STAFF MANAGERS PARTICIPATED
    - ASSURED TOTAL ORGANIZATIONAL INVOLVEMENT
- COMMUNICATED PLANS CONTINUOUSLY WITH INTERESTED PARTIES

Figure 42

AGENDA

I CoFF PROJECT PLAN
- FY-82
- FY-83

II LAUNCH DAMAGE & MAJOR MODIFICATIONS

III STS SECOND LINE OF FACILITIES

IV LC-39 HOUSING

Figure 49

KSC FY-82 CoF BUDGET ESTIMATES

	($000)
SPACE SHUTTLE FACILITIES	15,965
O CONST. OF SOLID ROCKET BOOSTER PROCESSING & SEGMENT STORAGE FACILITIES	12,400
O MOD. TO FIRING ROOMS	3,100
C VAB HB 1&2 MODS (MINOR SHUTTLE-UNIQUE)	465
SPACE SHUTTLE PAYLOAD FACILITIES	0
KSC INSTITUTIONAL DISCRETE	1,720
O REPAIR OF OPERATIONS & CHECKOUT BUILDING ROOF	825
O CONSTRUCTION OF WASTE MATERIAL INCINERATOR	895
REHABILITATION AND MODIFICATIONS	1,925
O REHAB. & MOD OF VARIOUS BLDGS. FOR ENERGY CONSERVATION	450
O MODIFICATIONS TO CABLE PLANT	465
O MODIFICATIONS TO HYPERGOL INCINERATOR	130
O ADDITIONAL UCS SENSORS	475
O INSTALL AUTOMATIC SPRINKLER PROTECTION, M7-505	265
O MODIFICATIONS TO FIRE SUPPRESSION SYSTEM, WAREHOUSE	140
REPAIR	450
O REPAIR KENNEDY PARKWAY	450
MINOR CONSTRUCTION	236
O CONSTRUCTION OF HAZARDOUS WASTE STORAGE AREA	236
TOTAL	20,296

Figure 50

CURRENT ACTIVITIES

- IMPLEMENTATION STARTED
  - ESTABLISHED TEAMS TO DEFINE CONTRACT CONTENT AND CHARACTER IN KEEPING WITH PLANS
    - INTERFACE WITH INDUSTRY AND LABOR KEY INGREDIENT
    - FINALIZE IMPLEMENTATION DETAILS
    - PRECURSOR TO CONTRACT SELECTION ACTIVITIES
  - MAINTAINED POLICY OVERVIEW WITH CENTER STEERING GROUP
  - REAFFIRMED PLANNING DIRECTION WITH NASA MANAGEMENT

80

76

Figure 43

CURRENT ACTIVITIES

- BASE OPERATIONS CONTRACT STATUS
  - DEVELOPMENT TEAM STARTED SEPTEMBER 1981
  - FORMAL INDUSTRY CONFERENCE JAN 15 & 16, 1982 (162 ATTENDEES REPRESENTED 68 FIRMS AND 8 LABOR UNIONS)
  - PROCUREMENT PLAN IN NASA HEADQUARTERS
  - REQUEST FOR PROPOSAL SCHEDULED FOR RELEASE IN MARCH '82
  - CONTRACT AWARD SCHEDULED FOR OCTOBER '82
- SHUTTLE PROCESSING CONTRACT STATUS
  - DEVELOPMENT TEAM STARTED OCTOBER '81
  - TWO INDUSTRY CONFERENCES HELD IN SEP & OCT '81
    - CONFIRM PLANNING DIRECTION
    - SOLICIT COMMENTS CONCERNING PLAN FEASIBILITY AND TIMING
    - ESTABLISHED ASSESSMENT TEAM CONCEPT TO ANSWER QUESTIONS

Figure 44

CURRENT ACTIVITIES

- STS-3 ASSESSMENT TEAMS
  - SOLICITED INDUSTRY TO REVIEW STS-3 OPERATIONS
  - SELECTED EIGHT TEAMS TO PARTICIPATE
  - KSC NOT FUNDING ASSESSMENT TEAMS
  - RESULTS TO BE SHARED

- CARGO PROCESSING CONTRACT STATUS
  - DEVELOPING A BETTER UNDERSTANDING OF STS CARGO OPERATIONS
  - ASSURING SHUTTLE PROCESSING CONTRACT AND BASE OPERATIONS CONTRACT WORK CONTENT COMPATIBLE WITH BASIC PLANNING

Figure 45

STS-3 OPERATIONS ASSESSMENT TEAMS	NUMBER OF PARTICIPANTS
UNITED SPACE BOOSTERS, INC	96
ROCKWELL INTERNATIONAL	66
GRUMMAN AEROSPACE CORPORATION	59
BOEING SERVICES INTERNATIONAL, INC.	25
LOCKHEED CORPORATION	24
GENERAL DYNAMICS, CONVAIR DIVISION	12
MARTIN MARIETTA AEROSPACE	10
UNITED AIRLINES	5

Figure 46

CURRENT ACTIVITIES

- CIVIL SERVICE ACTIVITIES
  - MANAGING ON-GOING STS AND ELV OPERATIONS
  - DEVELOPING MANAGEMENT METHODS COMPATIBLE WITH NEW CONTRACTS
  - DEVELOPING PLANS FOR TRANSITION INTO THE STS OPERATIONS PERIOD
  - PLANNING MULTI-FLOW OPERATIONS
  - DEVELOPING CARGO PROCESSING PLANS
  - SUPPORTING AIR FORCE ACTIVATION AT VANDENBERG AFB
  - PARTICIPATING IN AGENCY's FUTURE PLANNING
- PROJECT HEAVY WORKLOAD INTO 1985

Figure 47

KENNEDY SPACE CENTER

SPACE TRANSPORTATION SYSTEM FACILITIES REVIEW

97

BY

P.A. MINDERMAN

DIRECTOR OF DESIGN ENGINEERING

81

FEBRUARY 5, 1982

Figure 48

KSC
DESIGN ENGINEERING DIRECTORATE

SRM PSF
O&E PANEL REVIEW

A. TERAN
DEC 1981

SITE PLAN - PHASE I

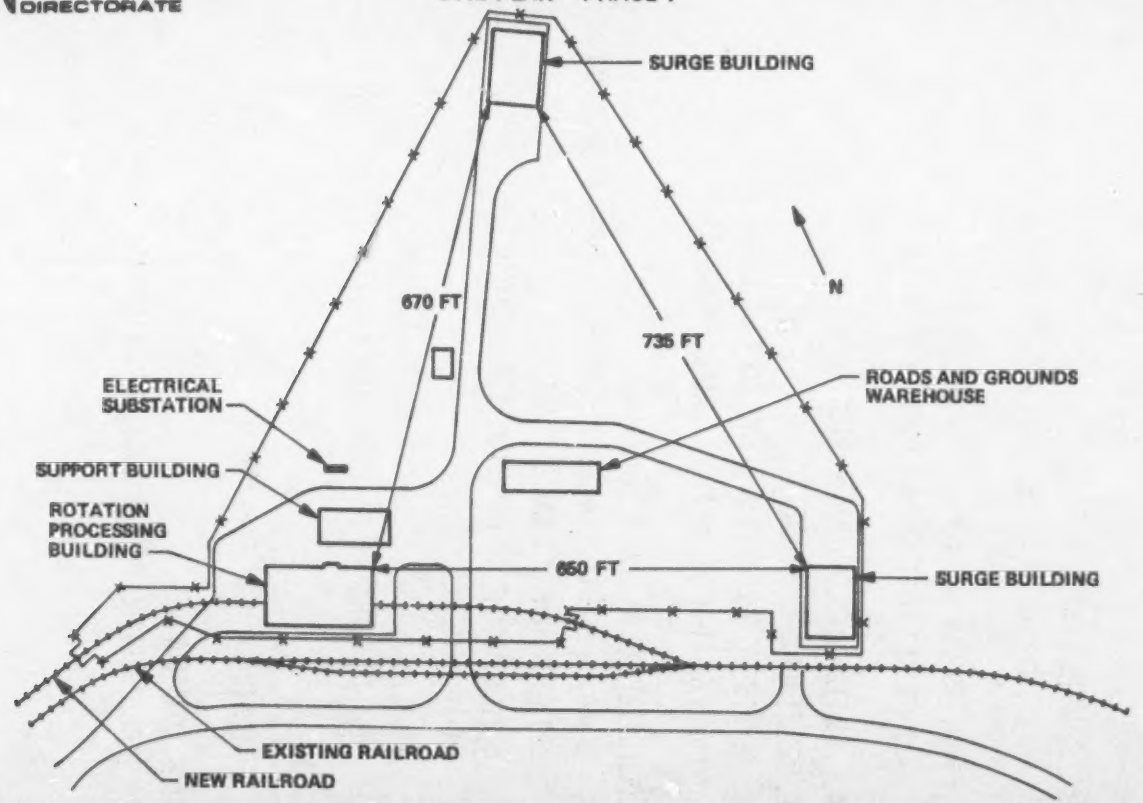

Figure 51

Figure 52. Area In Foreground Will Accomodate New Facility.

SRB ROTATION AND PROCESSING FACILITY

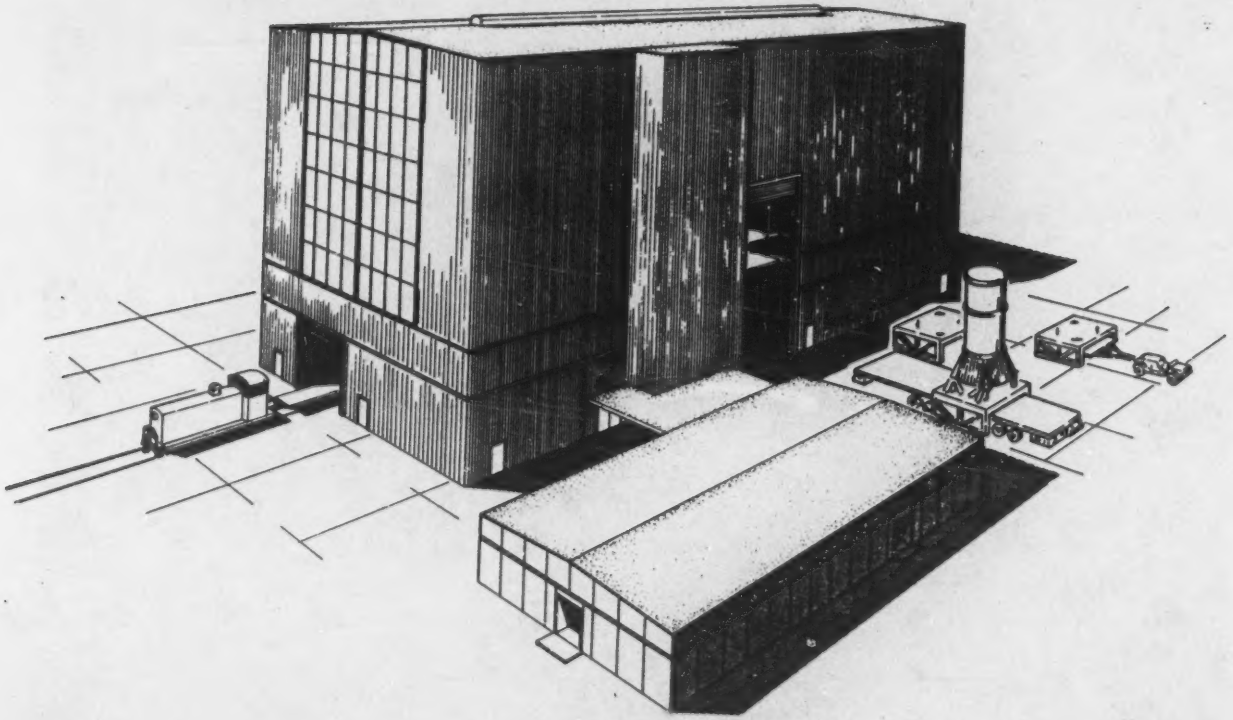

Figure 53

Figure 54

COMMON CARGO/SRM TRANSPORTER

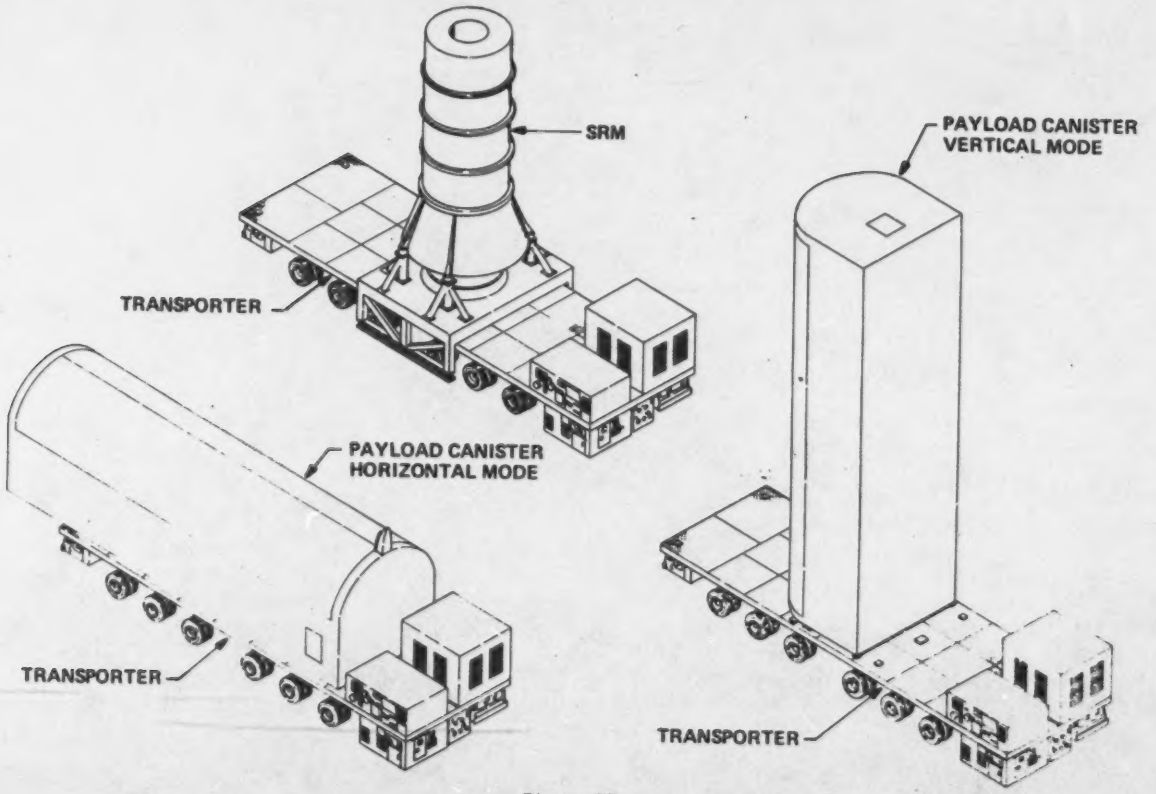

Figure 55

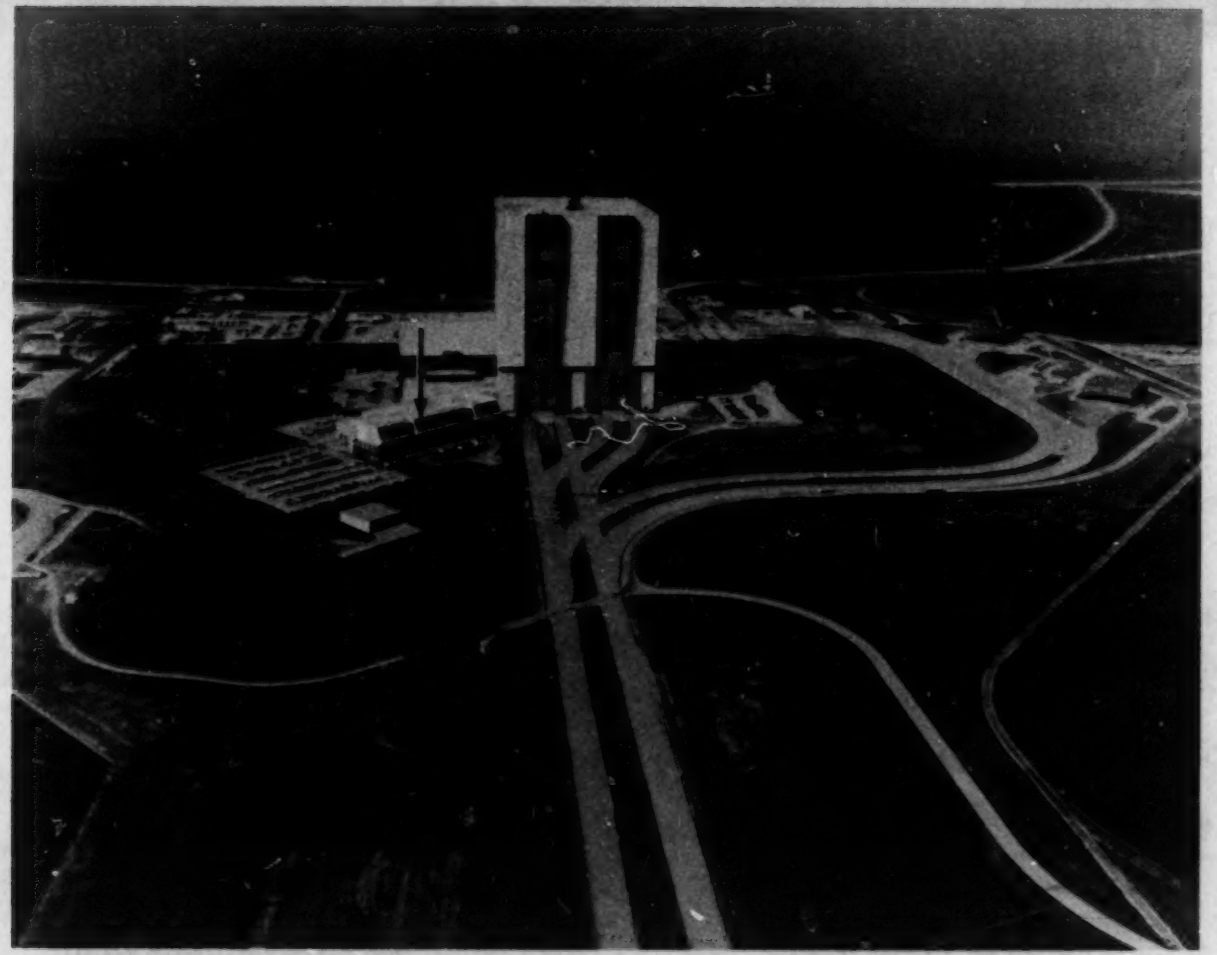

Figure 56. Changes Planned for Firing Room 3.

Figure 57. The Inside of a Firing Room.

KSC FY-83 CofF BUDGET ESTIMATES

	($000)
SHUTTLE	2,840
o ADD. TO SRB REFURB. FACILITY	1,700
MINOR SHUTTLE UNIQUE	1,140
o REHAB. PAD B POWER DIST. SYSTEM	(350)
o MOD M7-505 FOR FLIGHT KITS	(460)
o ADD. WORKING, PROC. & STORAGE FACILITY	(135)
o REPLACE MSBL-s TEM. CABLES AT WHITE SANDS	(195)
CARGO	1,740
REHAB & MOD FOR PAYLOAD GROUND SUPPORT OPERATIONS	1,740
o PAYLOAD USER ROOM #3 CABLES	(255)
o MOD ESA-60 WATER DELUGE & HAZARD PROOF	(420)
o MOD DSTF - WATER DELUGE & HAZARD PROOF	(180)
o BASELINE DATA COLLECTION FACILITY	(260)
o ADD. CABLE - CD&SC TO XY	(625)
INSTITUTIONAL	2,070
DISCRETE	0
MOD & REHAB	1,140
o MOD POWER, HVAC & UCS/CCS FOR OPS ERA	(110)
o ADD. SENSORS IN 60 Hz POWER SYSTEM	(150)
o ADD. ENERGY MONITORING & CONTROL OF UTILITIES	(290)
o INSTALL POWER METERING AT CCAFS	(140)
o INCREASE CAPACITY STP #4	(450)
MINOR CONSTRUCTION	0
REPAIR	930
o REPAIR CIF ROOF	(380)
o REPAIR KENNEDY PARKWAY - NASA PARKWAY TO GATE 2	(400)
o REPAIR PAVED AREAS AT FOUR FACILITIES	(150)
TOTAL	$6,650

Figure 58

93-418 O—82——7

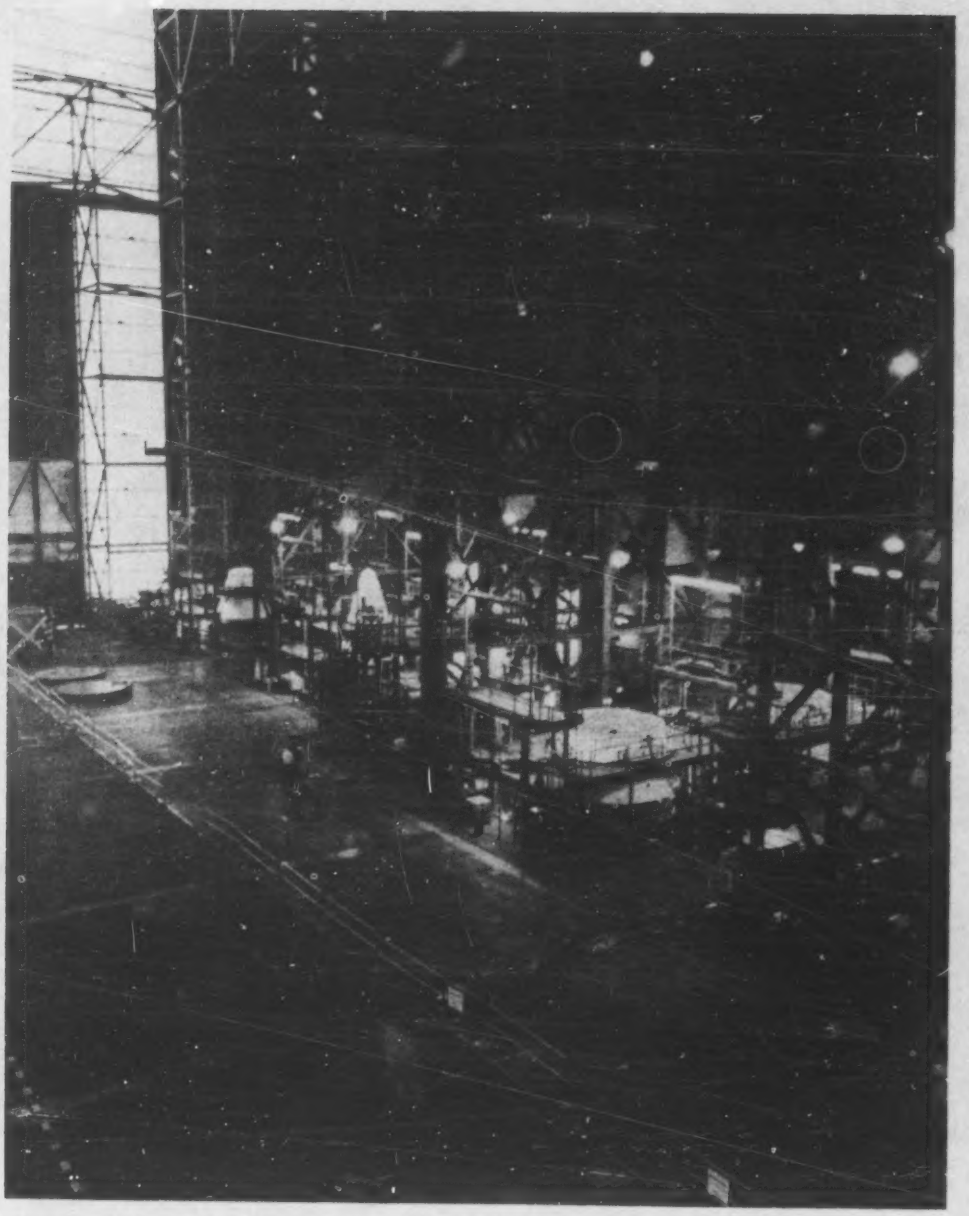

Figure 59. Relocation Planned for Refurbishment Facilities.

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1983 ESTIMATES
REHABILITATION AND MODIFICATIONS
FOR PAYLOAD GROUND SUPPORT OPERATIONS

LOCATION PLAN

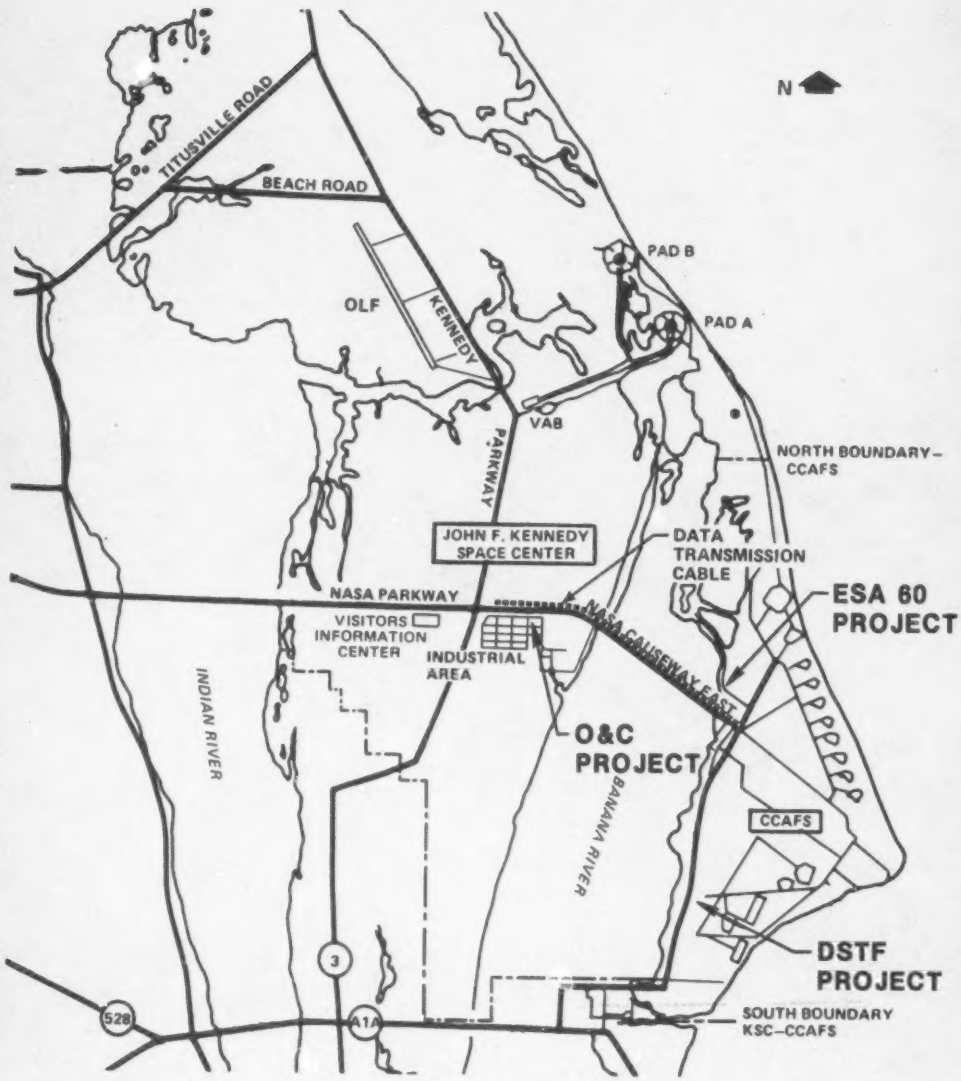

Figure 62

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1983 ESTIMATES
REHABILITATION AND MODIFICATIONS FOR
PAYLOAD GROUND SUPPORT OPERATIONS

PICTORAL VIEW – O&C BUILDING

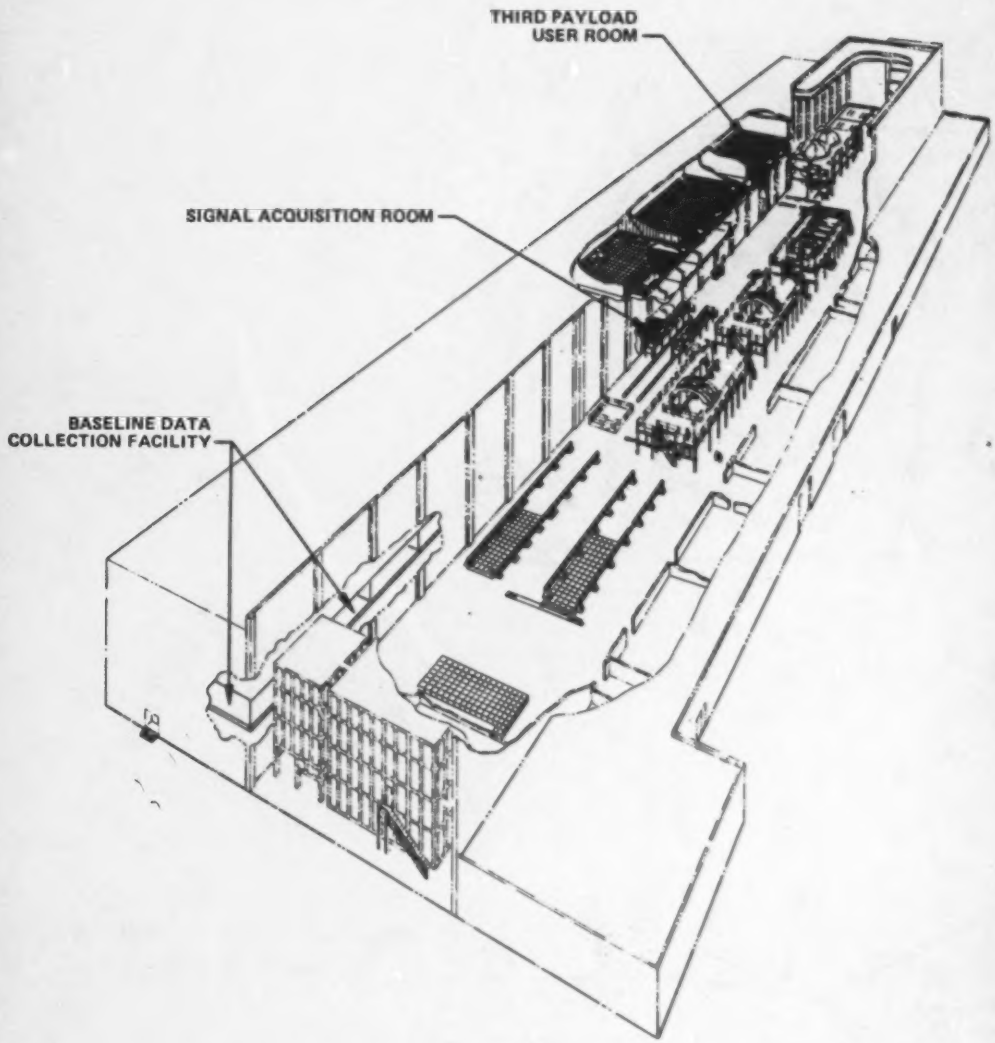

Figure 63

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1983 ESTIMATES
MODIFICATIONS OF SRB REFURBISHMENT AND
SUBASSEMBLY FACILITIES

FLOOR PLAN

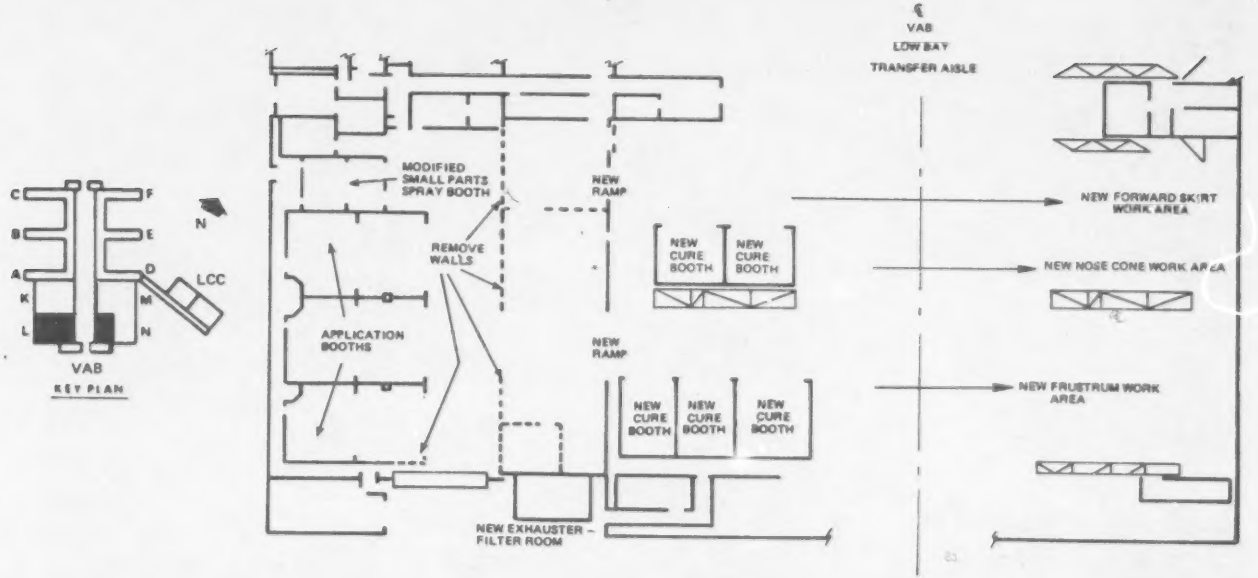

Figure 60

Figure 61. Hangar N at Cape Canaveral AF Station.

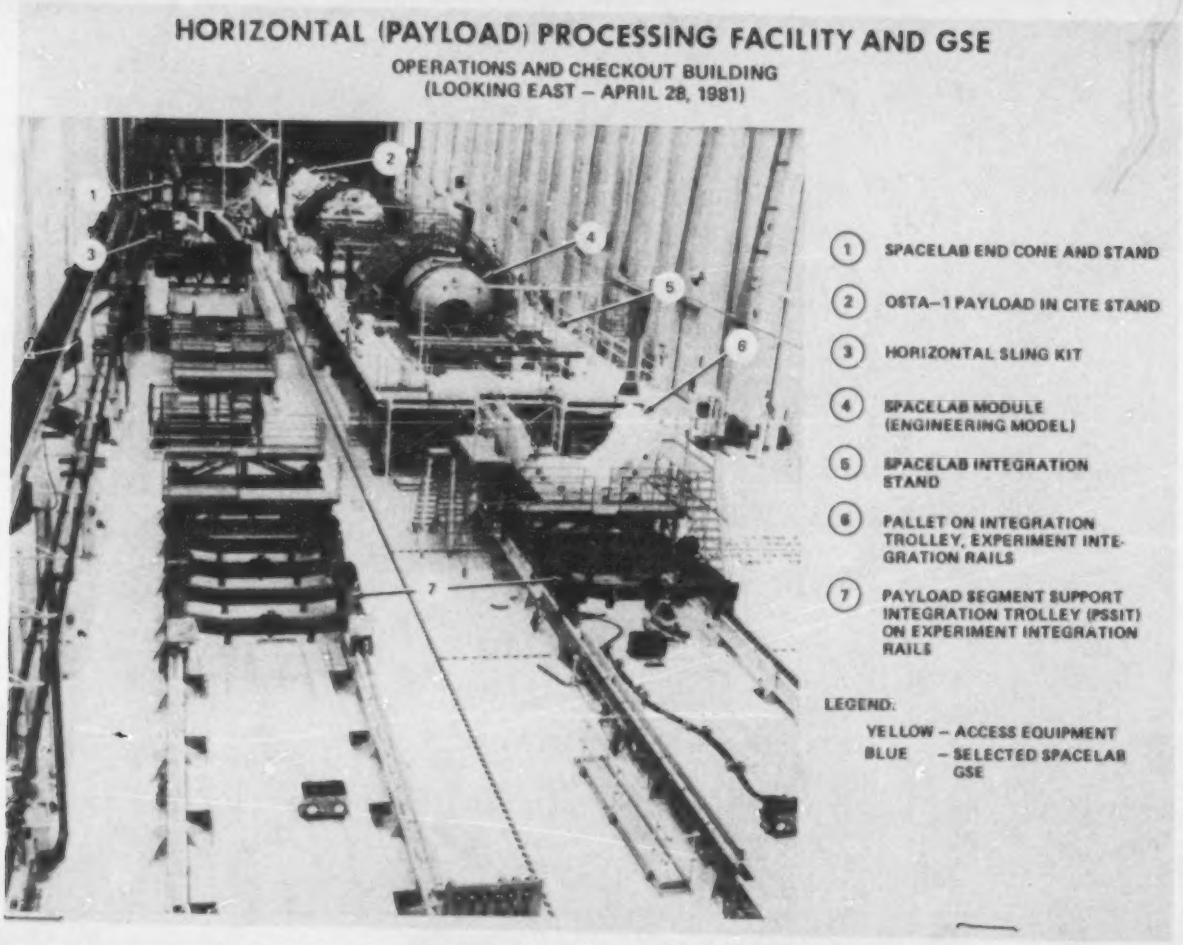

Figure 64. Horizontal Payload Processing Facility in O&C Building.

LAUNCH DAMAGE AND MAJOR MODIFICATIONS

- FACILITY DAMAGE MINOR — STS-1 - $810,000 — STS-2 - $351,000
  - PAD OPERATIONS SUPPORT BUILDING
  - ELEVATOR
  - 95 FOOT LEVEL
- OVER PRESSURE ON ORBITER
  - MODIFIED MOBILE LAUNCHER PLATFORM #1 FOR STS 2

Figure 65

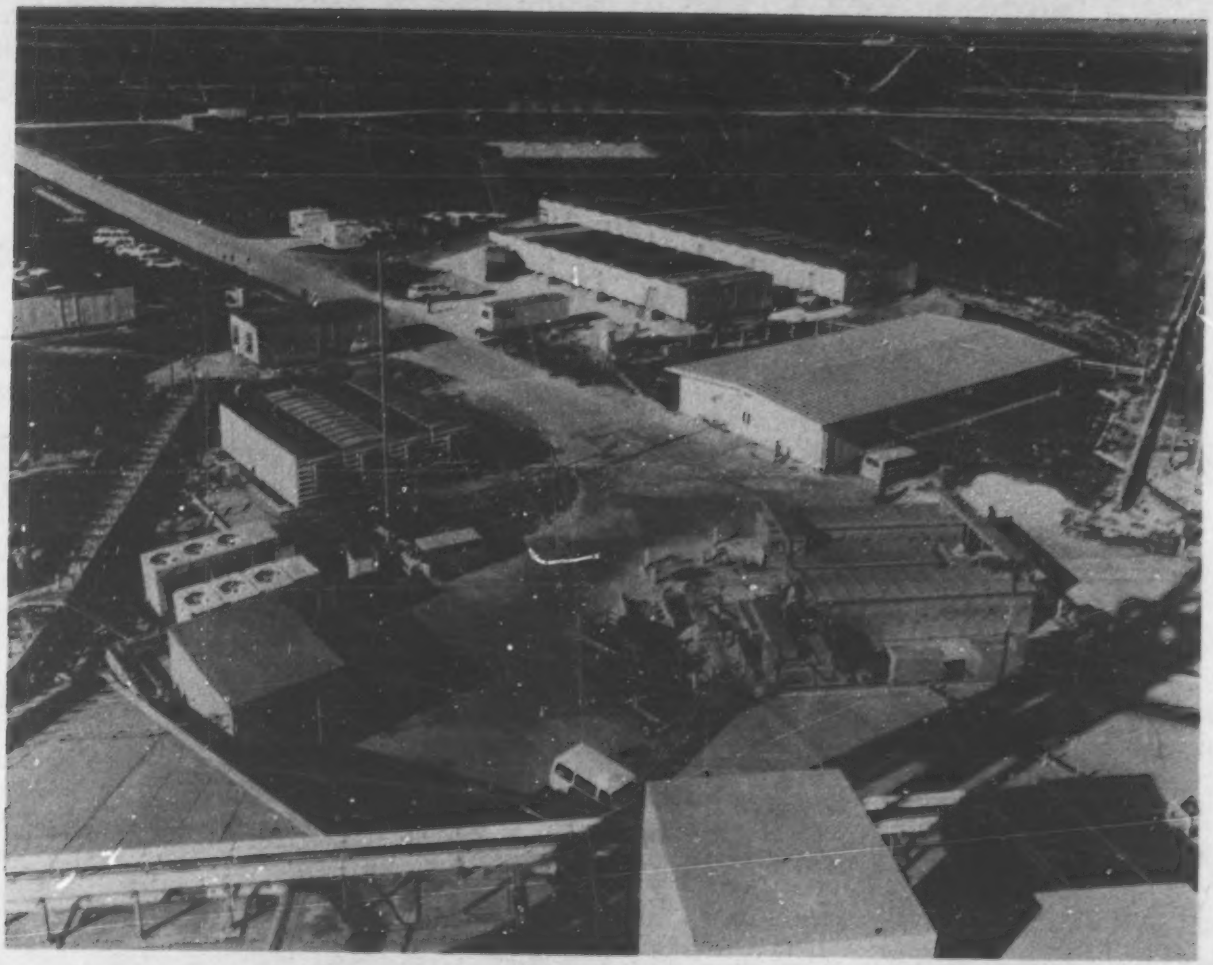

Figure 66. Surplus Boxcars Were a Possible Solution.

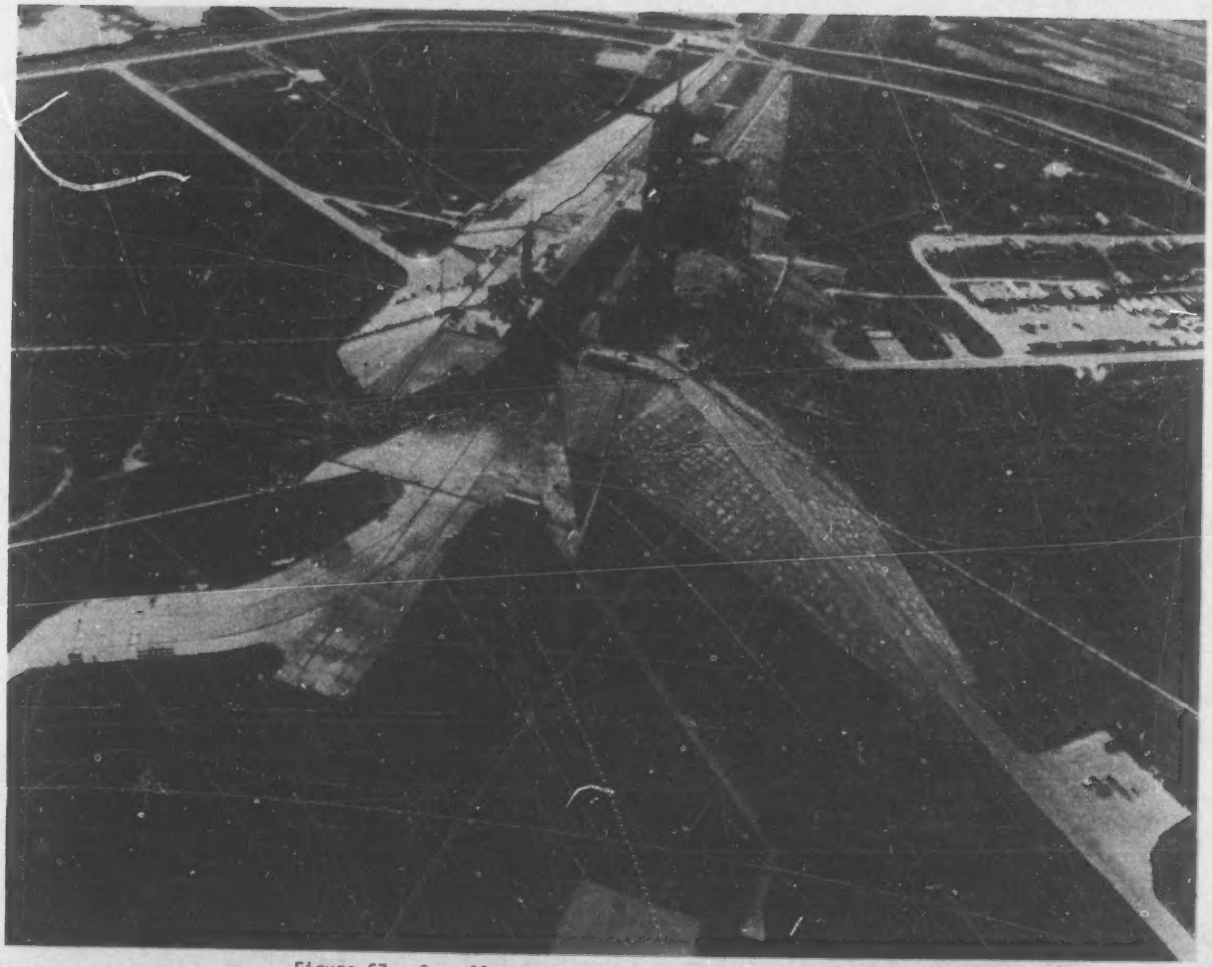

Figure 67. Overall View of Pad A, Looking North to South.

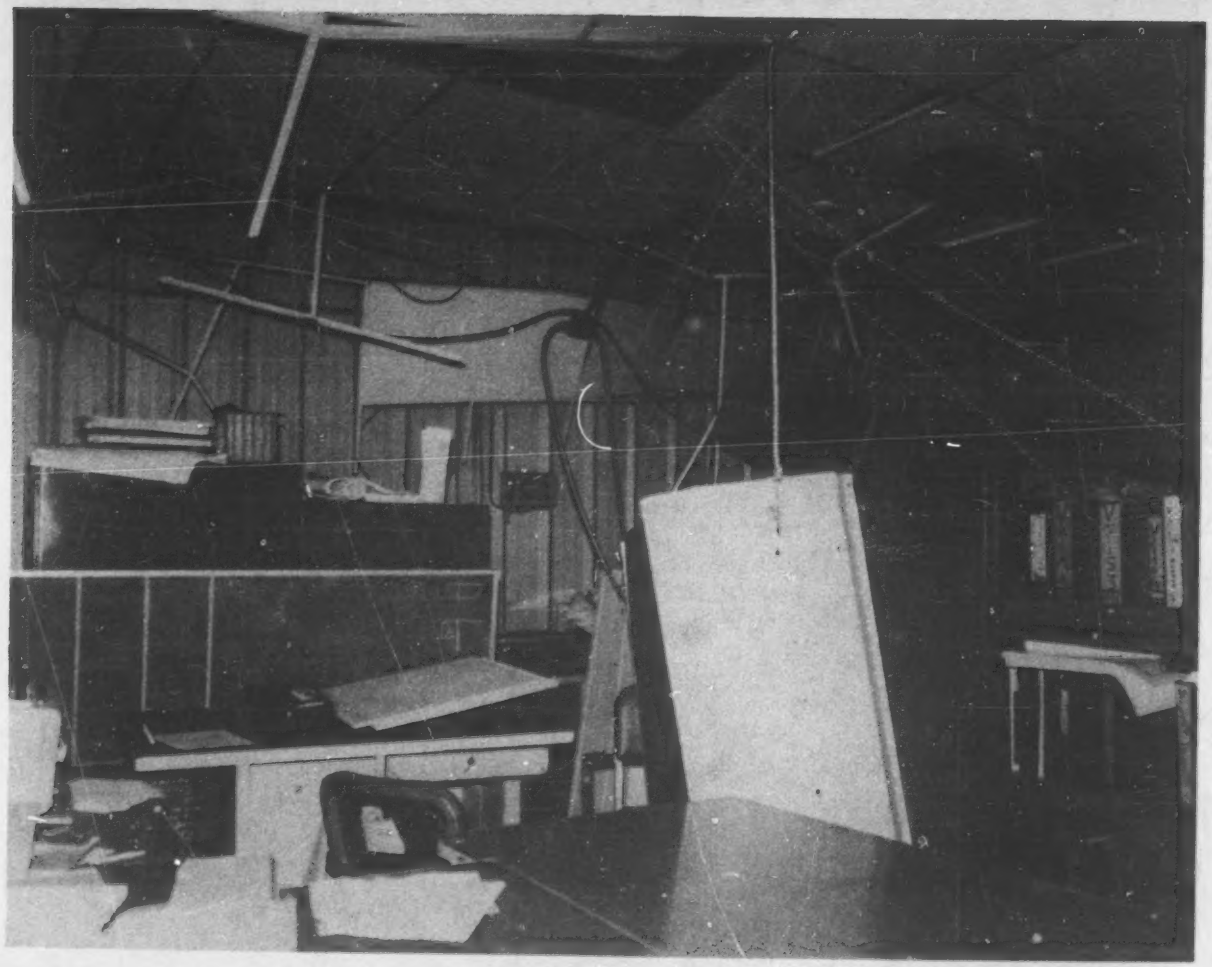

Figure 68. After Launch, In A "Prefab."

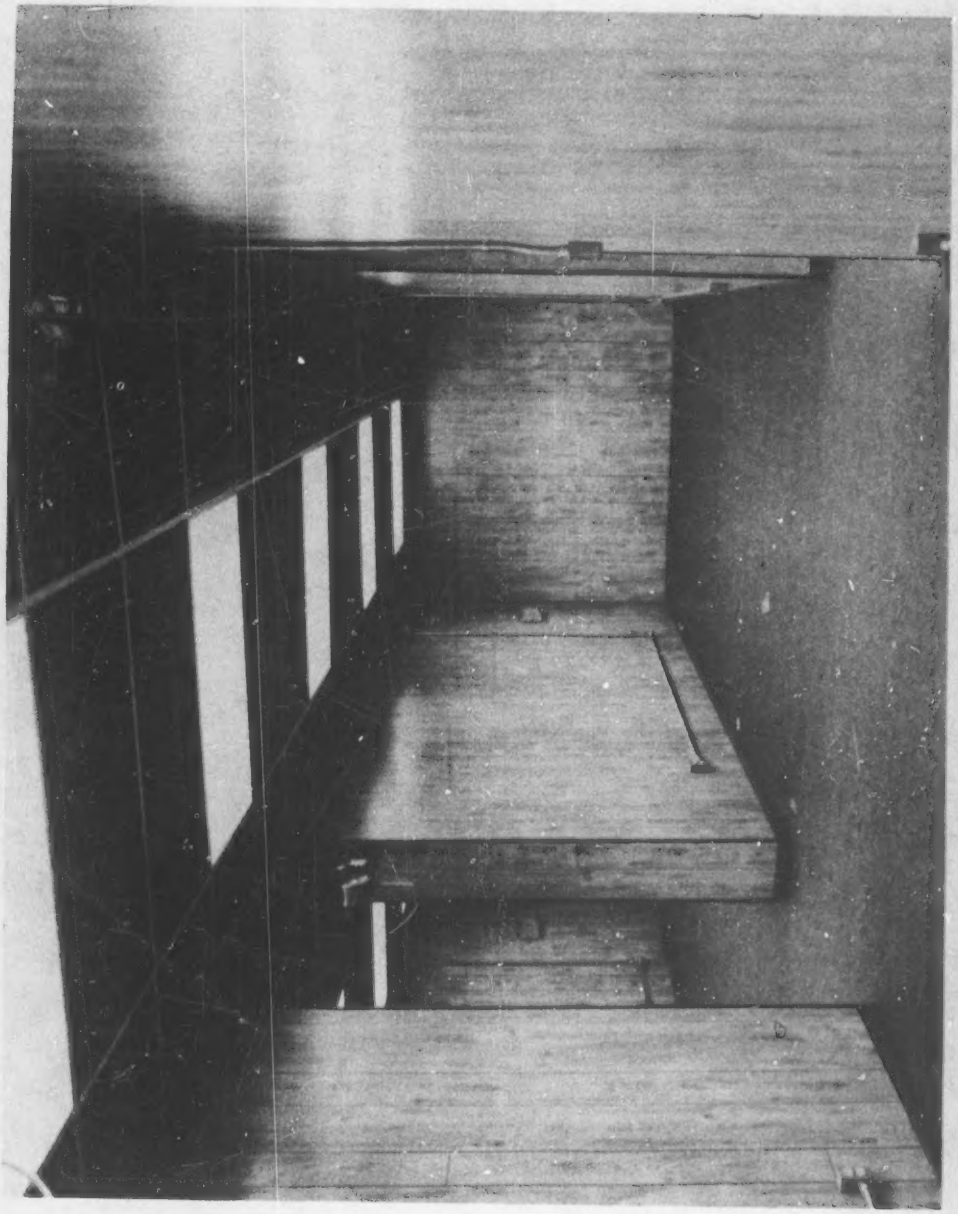

Figure 69. Boxcar Space Is Sturdy -- But Fragmented.

Figure 70. Elevator Doors Were Launch Casualties.

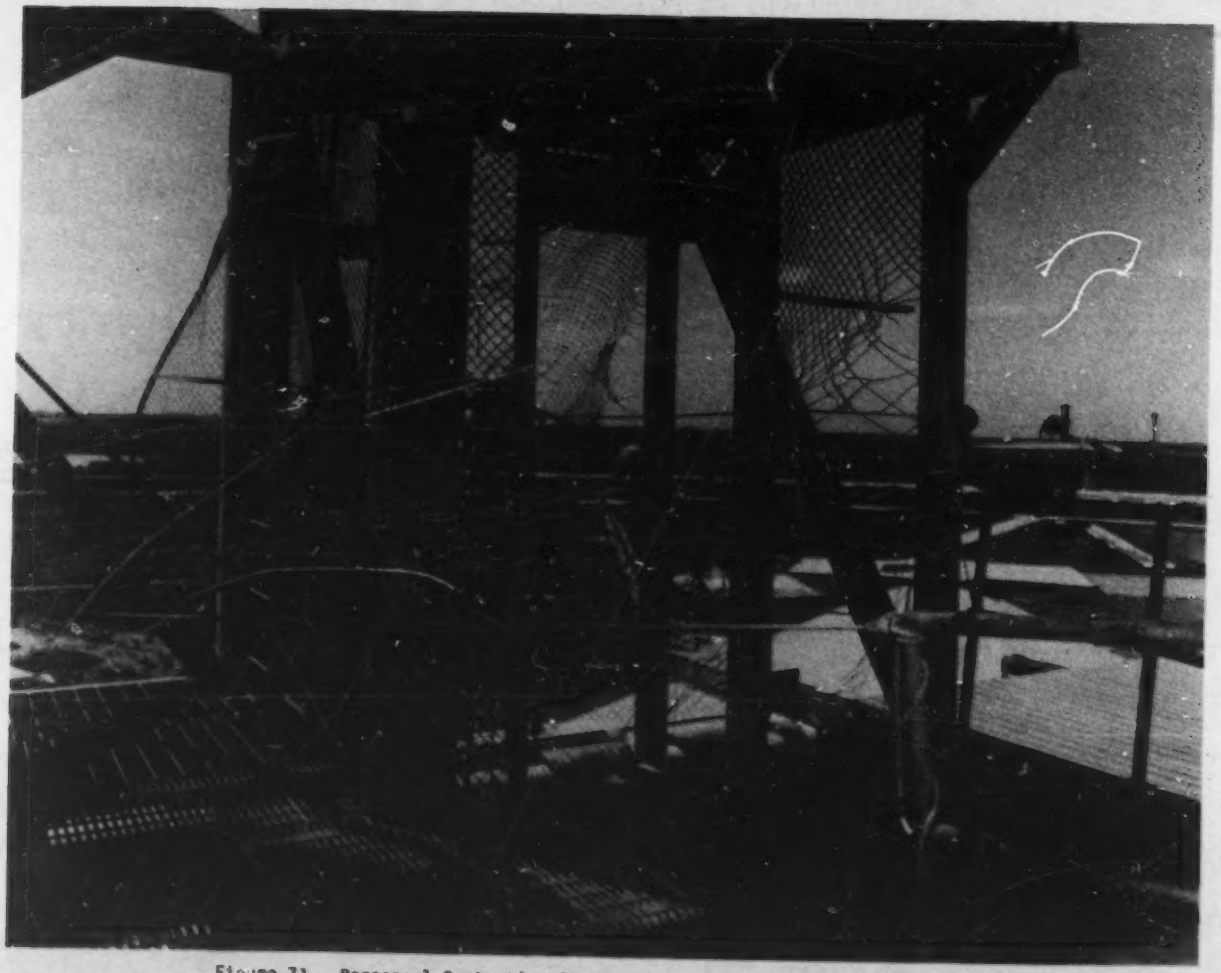

Figure 71. Personnel Protection Structures Suffered From Launch Forces.

Figure 73. Some Cables Were Torn Away From Connectors.

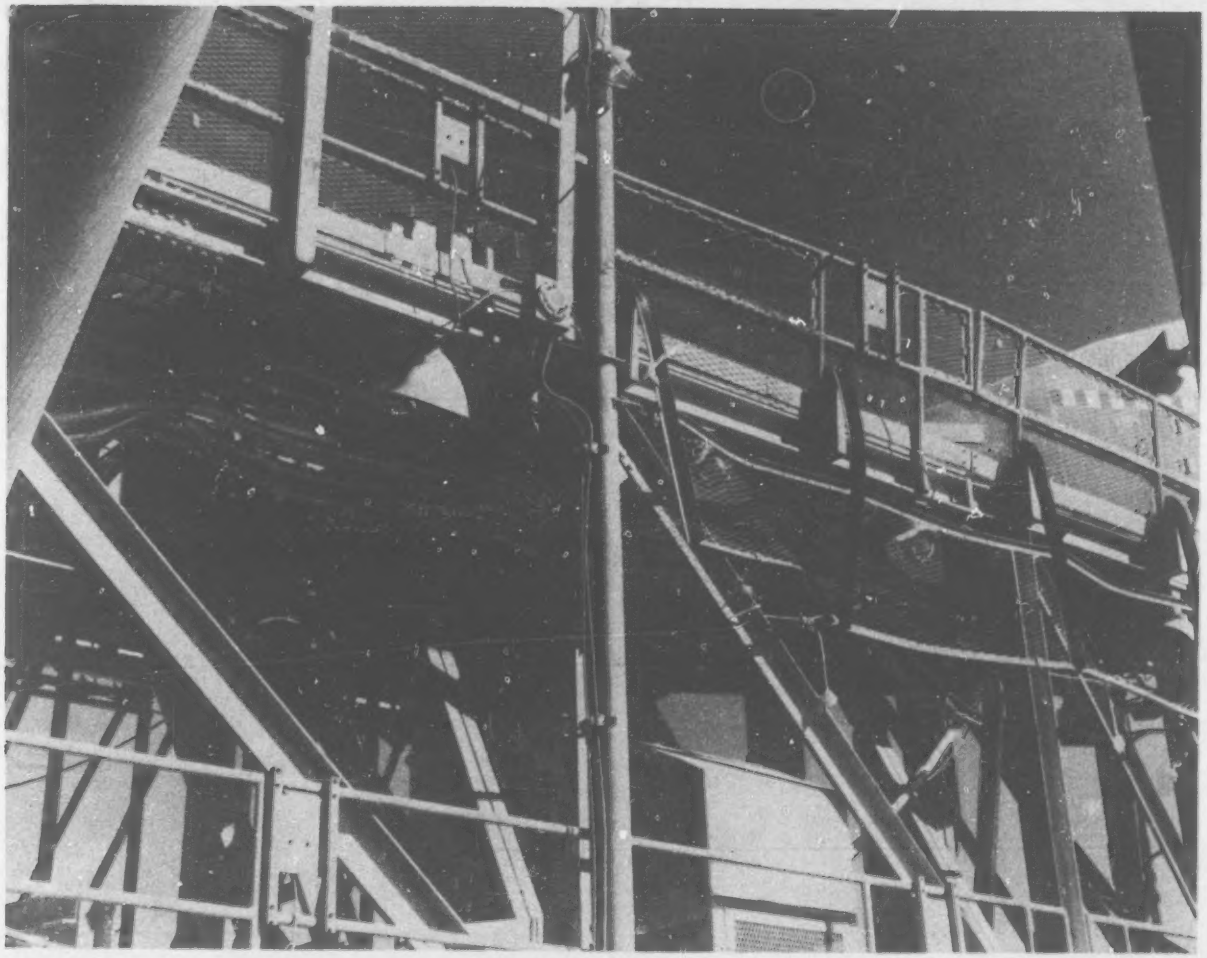

Figure 72. People Restraints Don't Hold Launch Forces.

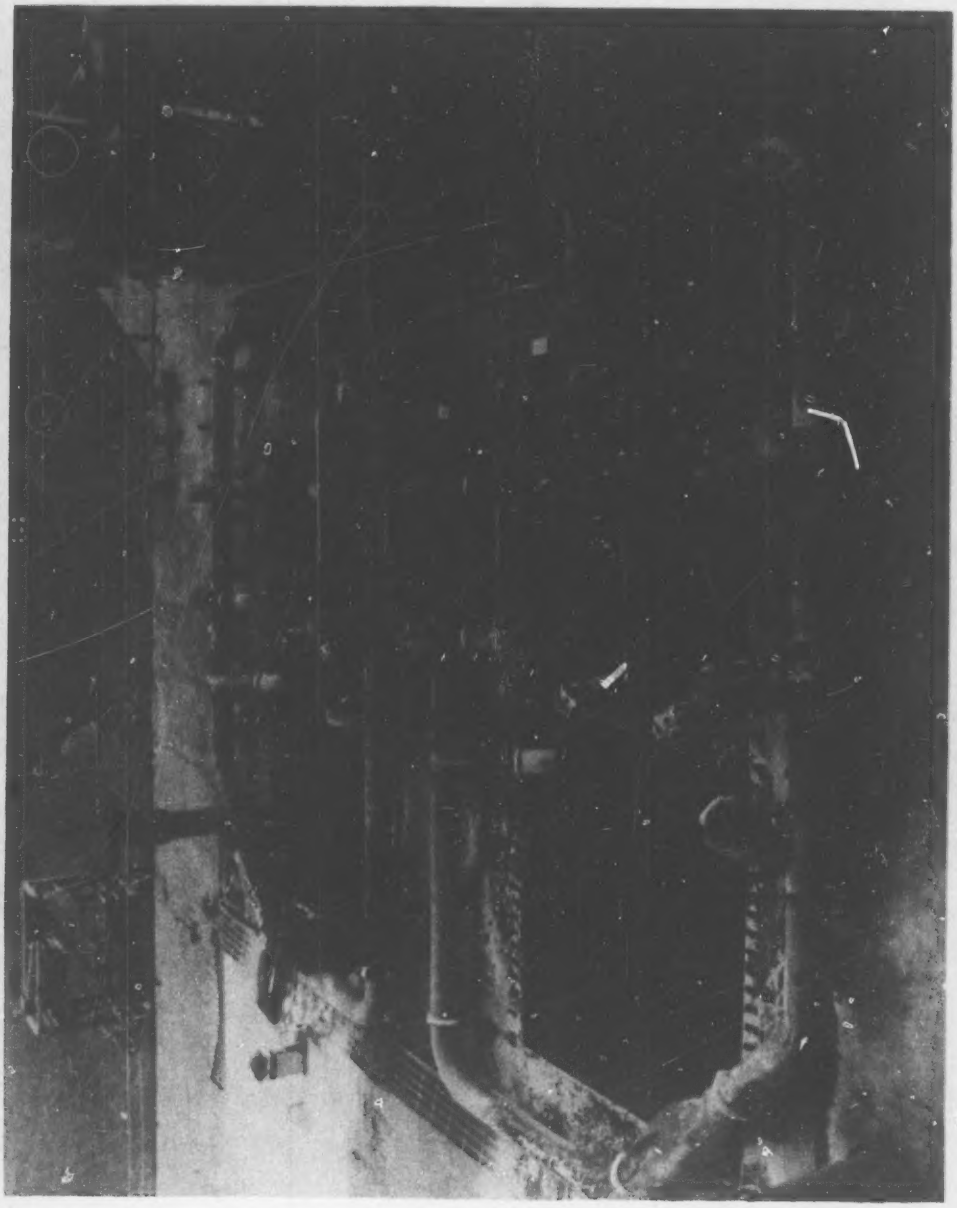

Figure 74. Water Injection Was Added For STS-2.

136

Figure 75. Water Troughs Absorbed STS-2 Pressure Wave.

STS SECOND LINE OF FACILITIES

- CoFF WORK COMPLETE OR IN WORK
  - ORBITER PROCESSING FACILITY (OPF) HIGH BAY 2 - CoFF PORTION COMPLETE DECEMBER 1978
  - VEHICLE ASSEMBLY BUILDING (VAB) HIGH BAY 1 AND 2 - CoFF PORTION COMPLETE DECEMBER 1978 (EXCEPT MINOR MODS - $0.3M)
    - MINOR MODIFICATIONS ESTIMATED COMPLETE - JULY 1982
  - MOBILE LAUNCHER PLATFORM (MLP) #2 - CoFF PORTION COMPLETE OCTOBER 1980
  - LC-39 PAD B - IN WORK
  - CRAWLER TRANSPORTER (CT) MAINTENANCE FACILITY - COMPLETE OCTOBER 1981
  - MODS FOR THERMAL PROTECTION SYSTEM (TPS) FACILITY - COMPLETE APRIL 1981
- R&D OUTFITTING
  - ORBITER PROCESSING FACILITY HIGH BAY 2
  - VEHICLE ASSEMBLY BUILDING HIGH BAY 1 AND 2
  - MOBILE LAUNCHER PLATFORM #2
  - LC-39 PAD B

Figure 76

ORBITER PROCESSING FACILITY

HIGH BAY (HB) 2 R&D OUTFITTING

DESCRIPTION

- EQUIP AND INSTALL ITEMS IN EXISTING HB 2 TO OBTAIN A MIRROR IMAGE OF HB 1 TO PROVIDE SECOND OPERATIONAL HIGH BAY FOR ORBITER PROCESSING.
- INSTALL WORK STANDS
- INSTALL SYSTEMS
- ENVIRONMENTAL CONTROL SYSTEM FOR ORBITER (INCLUDES HB 1)

STATUS

- DESIGN UPDATE COMPLETE OCTOBER 1980
- INSTALLATION START DECEMBER 1980
- ESTIMATE COMPLETION FEBRUARY 1982
- OPERATIONAL READY DATE JUNE 1982

Figure 77

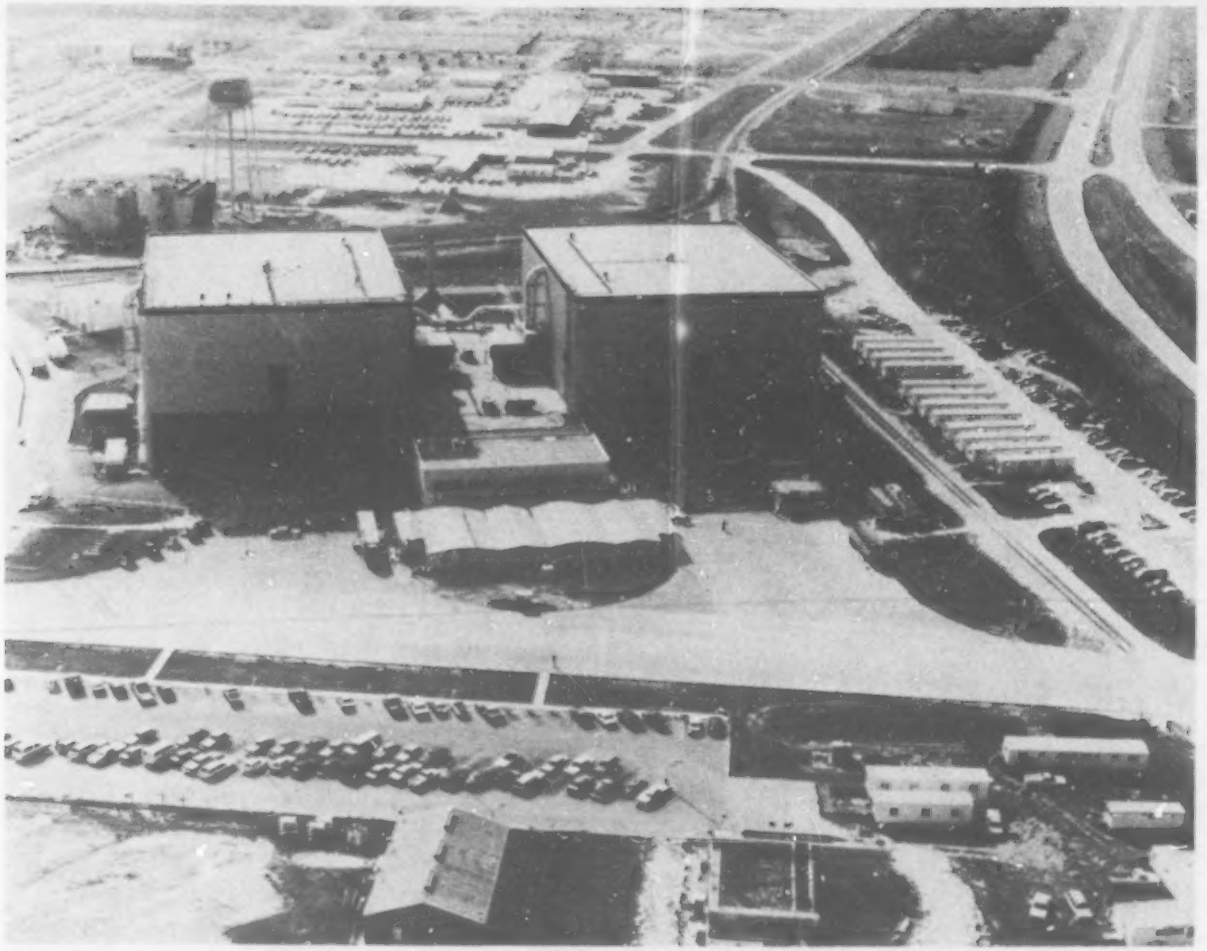

Figure 78. Both OPF High Bays Were Built At Once.

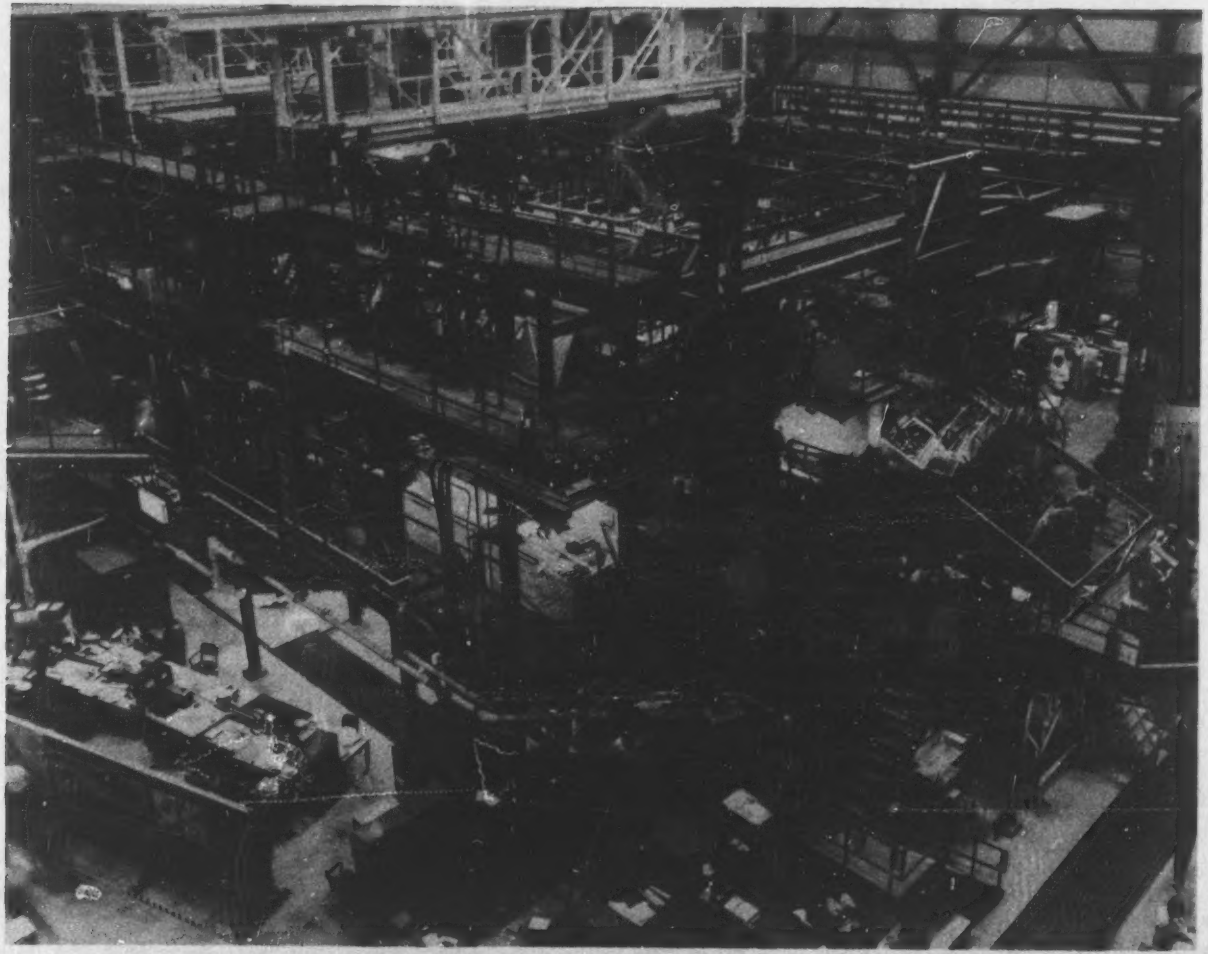

Figure 79. A Completed OPF High Bay.

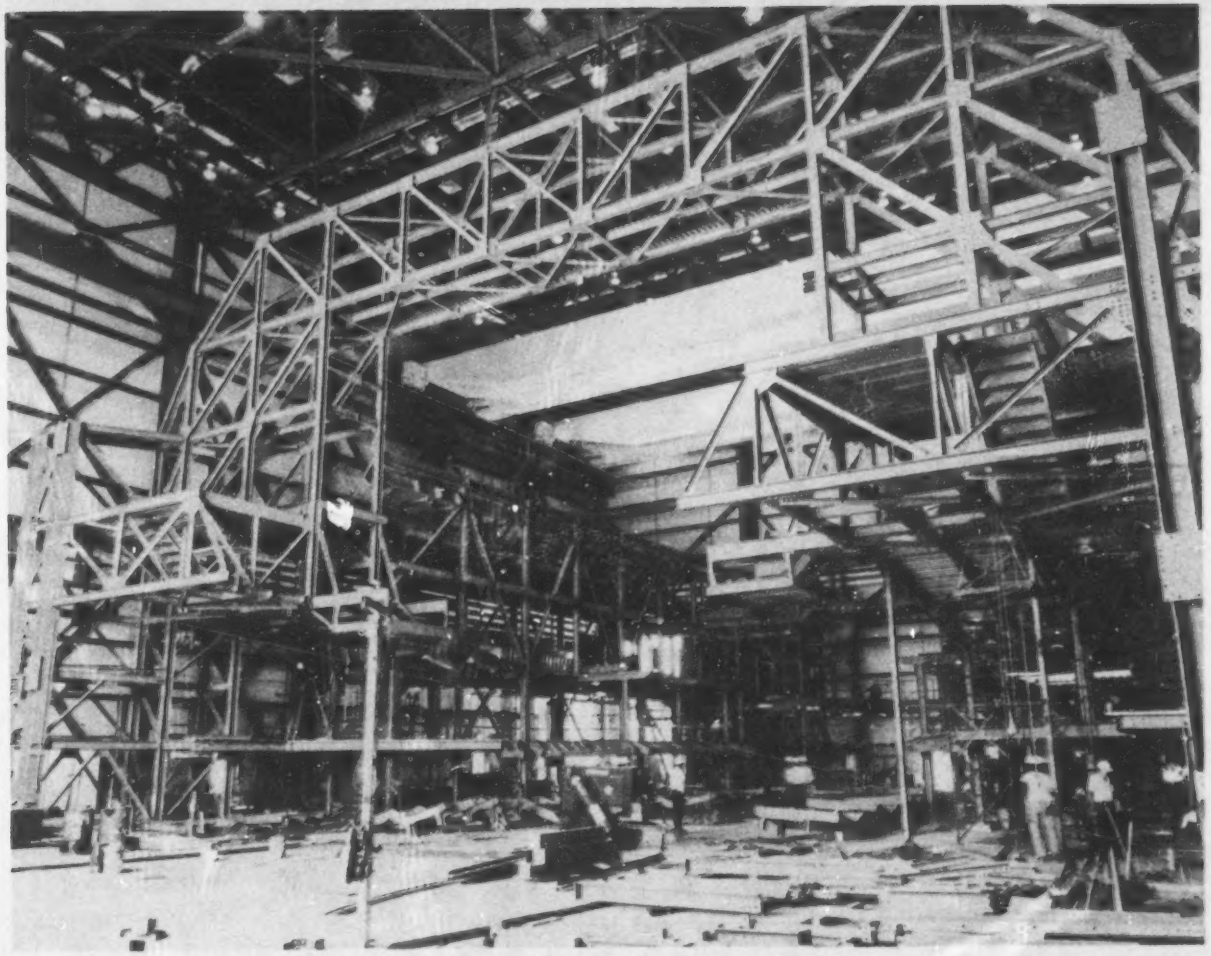

Figure 80. An OPF High Bay Under Construction.

VEHICLE ASSEMBLY BUILDING
HIGH BAYS 1 AND 2 R&D OUTFITTING

DESCRIPTION

- PROCURE AND INSTALL SYSTEMS AND GROUND SUPPORT EQUIPMENT FOR SHUTTLE VEHICLE INTEGRATION IN HB-1 AND FOR ET PROCESSING AND STORAGE IN HB-2.

STATUS

- HB 1 AND 2 DESIGN UPDATE COMPLETE FEBRUARY 1982
- ESTIMATED COMPLETION SEPTEMBER 1982
- OPERATIONAL READY DATE JUNE 1983

Figure 81

MOBILE LAUNCHER PLATFORM #2
R&D OUTFITTING

DESCRIPTION

- INSTALL TEST AND VALIDATE GROUND SUPPORT EQUIPMENT
- INCORPORATE CHANGES INCLUDING OVERPRESSURE MODIFICATIONS

STATUS

- DESIGN UPDATE COMPLETE JULY 1980 (OVERPRESSURE DECEMBER 1981)
- OUTFITTING COMPLETE AUGUST 1982
- OPERATIONAL READY DATE SEPTEMBER 1982

Figure 82

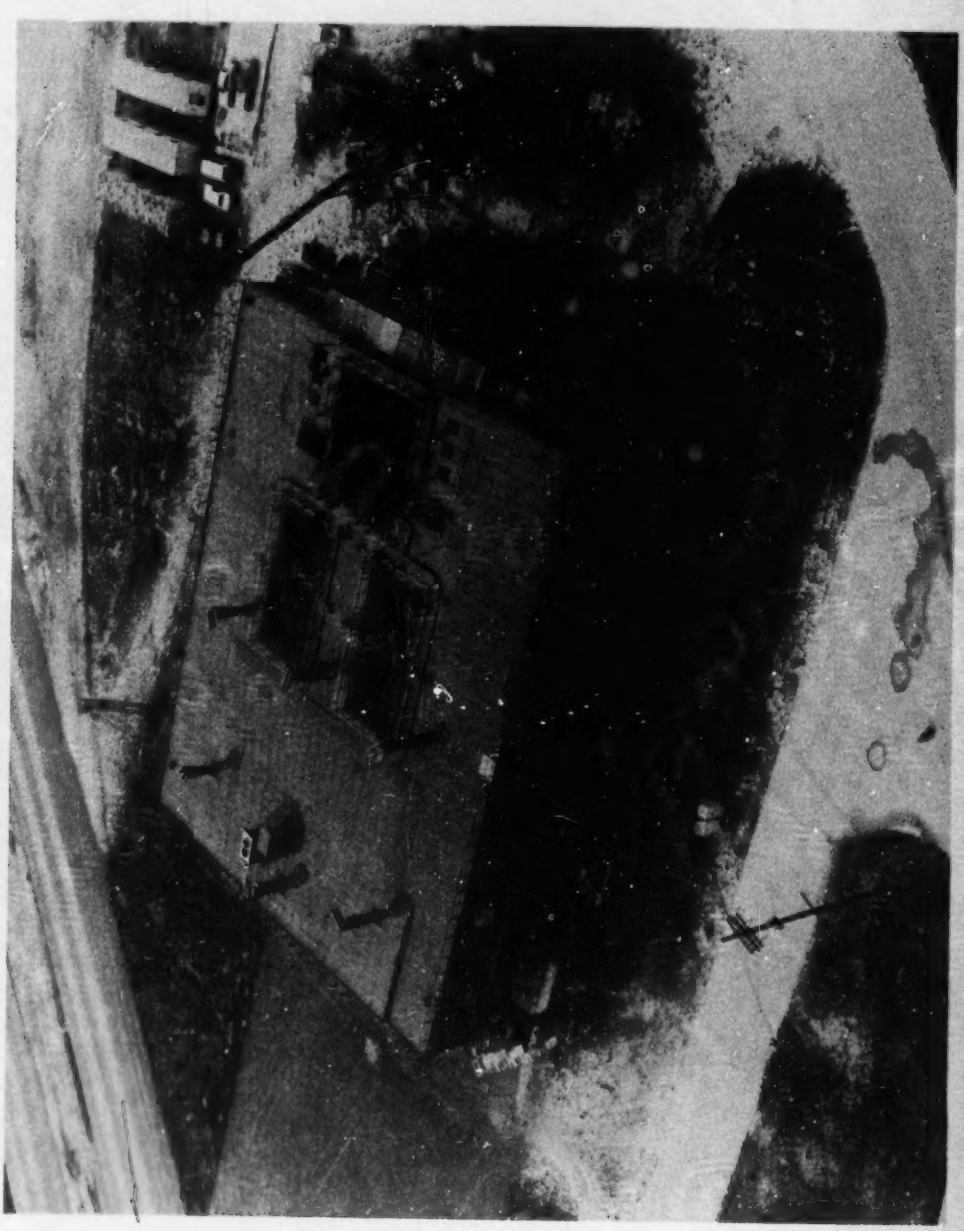

Figure 83. A Completed Mobile Launcher.

LAUNCH COMPLEX 39

PAD B

(FY-78, 79, AND 80)

DESCRIPTION

- PROVIDE A SECOND SHUTTLE SERVICING AND ACCESS FACILITY
  - PAYLOAD CHANGEOUT CAPABILITY
  - SHUTTLE VEHICLE ACCESS
- OUTFIT THE PAD WITH SYSTEMS AND EQUIPMENT FOR VEHICLE SERVICING AND CHECKOUT

STATUS

- CONTRACT 1 - BASIC MODIFICATIONS, FIXED SERVICE STRUCTURE & SOUND SUPPRESSION
  - CONTRACTOR FRANK BRISCOE CO.
  - COMPLETE OCTOBER 1980
- CONTRACT 2 - ROTATING SERVICE STRUCTURE
  - CONTRACTOR FRANK BRISCOE CO.
  - 98% COMPLETE
  - EST. COMPLETE FEBRUARY 1982
- CONTRACT 3 - FACILITY SYSTEMS
  - CONTRACTOR IVEY STEEL ERECTORS
  - 75% COMPLETE
  - EST. COMPLETE JUNE 1982

OPERATIONAL READY DATE SEPTEMBER 1986

CURRENT COST ESTIMATE: $53.2M

Figure 84

Statement of

R. G. Smith
Director

JOHN F. KENNEDY SPACE CENTER

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee:

I welcome this opportunity to present a status report on activities at the John F. Kennedy Space Center since the subcommittee's visit last year. 1981 was a year of spectacular firsts. More than ten years after work on the Space Shuttle Program began, the Center's workforce achieved success in one of its greatest challenges, launching the Space Shuttle Columbia — twice. STS-1 was launched on April 12, 1981 and STS-2 was launched on November 12, 1981. Both missions were successful although the second mission duration was cut short due to a malfunctioning fuel cell.

Shuttle Processing

Preparations for STS-3 are proceeding smoothly per our planned schedule. The Solid Rocket Boosters (SRB's) were stacked on the Mobile Launcher Platform (MLP) by December 9, the External Tank (ET) was mated to the SRB's on January 4, and just two days ago the operations to mate the Orbiter to the External Tank were started. The integrated vehicle will be in the Vehicle Assembly Building (VAB) for approximately 17 days during which time the major activity will be a Shuttle Interface Test.

93-418 O—82——9

The vehicle is scheduled to be transferred to the pad on February 19 for approximately one month of launch preparations. These launch preparations include six major tests: (1) launch pad validation, (2) countdown demonstration, (3) integrated cryogenic tanking test, (4) prelaunch propellant load, (5) countdown preparation, and (6) launch countdown. The launch date of STS-3 is March 22 at 10 a.m. Some elements for STS-4 have arrived at KSC and limited checkout of these elements has begun. The External Tank for STS-4 arrived at KSC on January 22, 1982 and currently is in the VAB ET checkout cell. The SRB aft skirts are being worked in the low bay area of the VAB. We expect to launch STS-4 on or about July 4.

In 1981, the long range plan to streamline operations and reduce costs was accelerated with the approval of the NASA Administrator. The overall plan is to have only three major contracts at KSC. The first, covering base operations or institutional support services, is scheduled to be awarded later this year. The Shuttle Processing Contract (SPC) could be awarded as soon as the summer of 1983. The third contract, for cargo processing, is not scheduled but is expected to follow the other two. By making the three major contractors as self-sufficient as possible, KSC should be able to reduce the number of daily contacts and approvals now required in direction of the work, give contractors more direct responsibility and incentive, and hold them more accountable for their performance.

First steps toward the Shuttle Processing Contract were taken when eight qualified companies were invited to KSC to observe the complete processing of STS-3. United Space Boosters, Grumman Aerospace, Boeing Services International, Lockheed Corporation, Martin Marietta Aerospace, Rockwell International, and United Airlines have assessment teams now at KSC. General Dynamics has withdrawn from the assessment. The invitation is an innovative approach to give potential bidders every opportunity to learn what it takes to prepare the Shuttle for flight in order to assure knowledgeable competition when proposals are solicited for SPC next fall.

Cargo Processing

Today, a Spacelab Ceremony will mark a historic cooperative space venture between ten European nations and the United States. The European Space Agency's (ESA's) Spacelab Flight Unit #1 (Module) was accepted in Europe and delivered to KSC in December 1981. The first Spacelab flight equipment arrived here December 11 in an Air Force C-5 cargo aircraft direct from its Breman, Germany, assembly plant. The first of two shipments received, it consisted of two pressurized module segments and two experiment pallets, plus some ground support equipment.

The second shipment arrived December 21 via a Lufthansa 747 cargo jet. It consisted of the scientific airlock plus nearly 50 crates of ground support and handling equipment. The Spacelab components and experiments now are undergoing assembly, checkout, and integration for the first flight. That flight now is scheduled to fly on STS-9 in September 1983.

Spacelab Engineering Model was utilized extensively throughout 1981 and will continue to be used in fit checks and development and verification of test procedures for Spacelab Flight Unit #1.

Another historic accomplishment was the processing and launch of OSTA-1 on STS-2. This was the first science and applications payload for the Shuttle program. The payload also was disassembled at KSC, and flight experiments were returned to the users. This mission successfully demonstrated the capability of the Shuttle for scientific and applications research in the attached mode.

OSS-1, the first space science payload, was transported to KSC from Goddard Space Flight Center where it had undergone experiments integration. The seven experiments cover the disciplines of space plasma, physics, astronomy and life sciences. At KSC, final assembly and cargo integration testing were completed in late 1981. OSS-1 was installed in Columbia in early January 1982 in

LC-39 PAD B

R&D OUTFITTING

DESCRIPTION

- PROCURE, INSTALL, TEST AND VALIDATE GROUND SUPPORT EQUIPMENT
- INCORPORATE CHANGES

STATUS

- DESIGN UPDATING COMPLETE OCTOBER 1982
- OUTFITTING COMPLETE OCTOBER 1985
- OPERATIONAL READY DATE SEPTEMBER 1986

149

118

Figure 85

LC-39 HOUSING

R&D

DESCRIPTION

- LEASE AND SETUP APPROXIMATELY 200 TRAILERS
- MOVE PEOPLE FROM VAB TO TRAILERS

STATUS

- DESIGN (SPECIFICATIONS) COMPLETE FEBRUARY 1982
- START DELIVERY AND HOOKUP MAY 1982
- ESTIMATED COMPLETION FEBRUARY 1983

CURRENT COST ESTIMATE: $4.3M

Figure 86

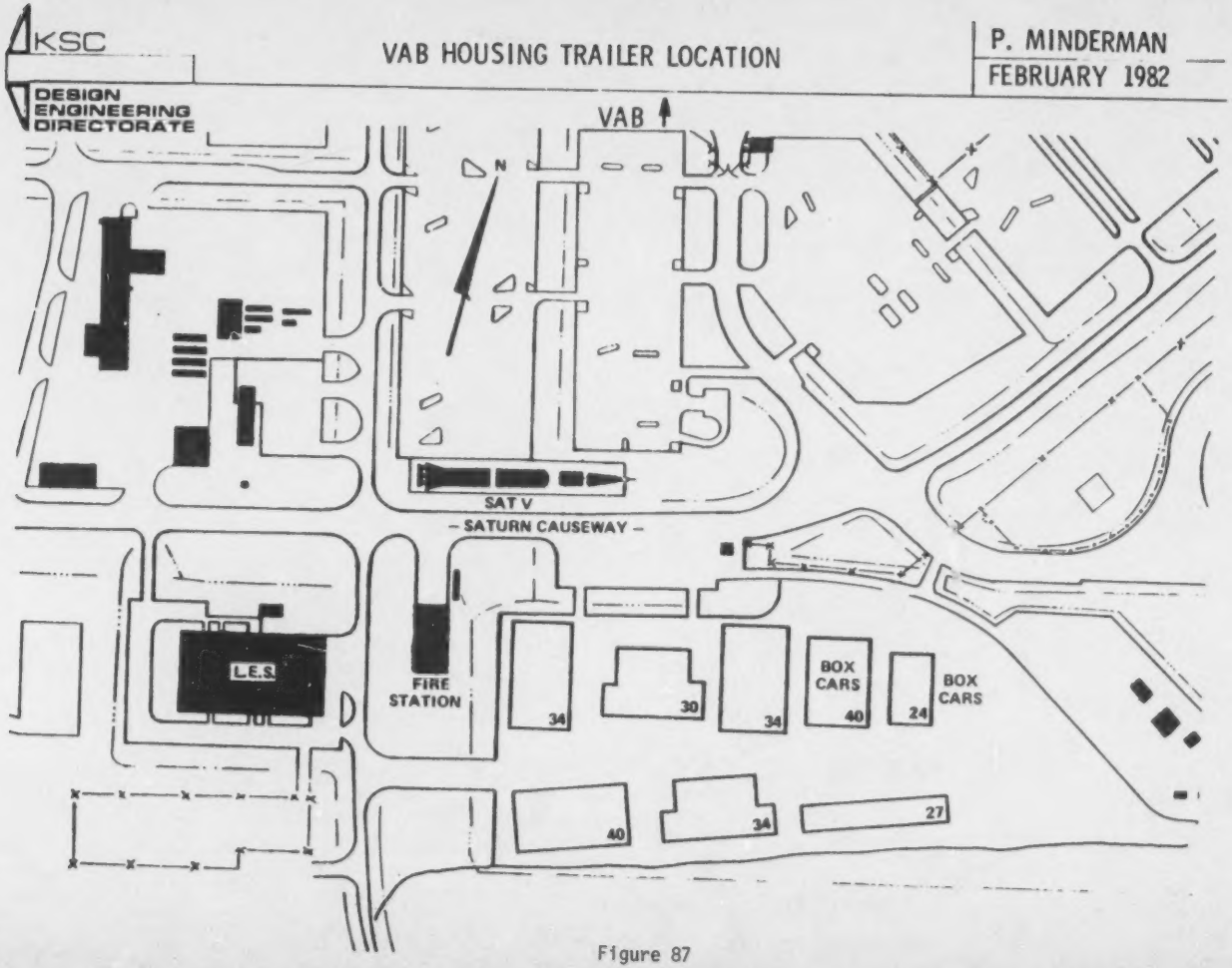
KSC
DESIGN ENGINEERING DIRECTORATE
VAB HOUSING TRAILER LOCATION
P. MINDERMAN
FEBRUARY 1982
VAB
N
SAT V
- SATURN CAUSEWAY -
L.E.S.
FIRE STATION
34
30
34
BOX CARS
40
24
BOX CARS
40
34
27

Figure 87

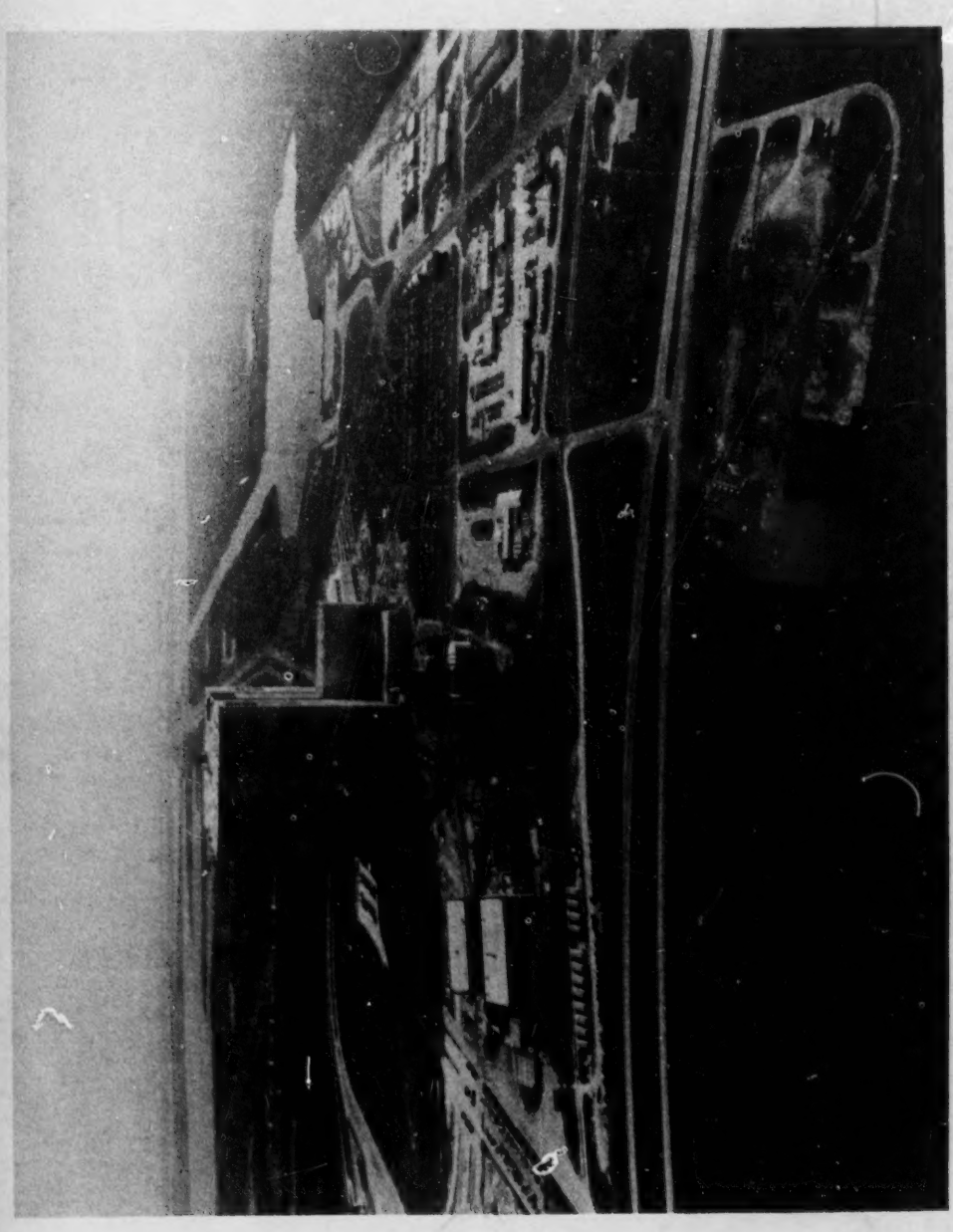

Figure 88. Support People Would Move To A Trailer Complex

SITE PREPARATION AND UTILITIES FOR LAUNCH COMPLEX 39 HOUSING

(FY-80 AND 81 REPROGRAMMING)

DESCRIPTION

- PREPARE SITE FOR APPROXIMATELY 200 OFFICE TRAILERS TO HOUSE APPROXIMATELY 1,200 PERSONNEL.
- PROJECT INCLUDES:
  - SITE PREPARATION
  - UTILITIES (ELECTRICAL POWER, COMMUNICATIONS, WATER & SEWER)

STATUS

- DESIGN COMPLETE MARCH 1982
- CONSTRUCTION START MAY 1982
- ESTIMATED COMPLETION NOVEMBER 1982

CURRENT COST ESTIMATE: $2.7M

153

122

Figure 89

preparation for the STS-3 launch. Interface verification and payload compatibility testing were completed in late January 1982.

A prototype of the Small Self-Contained Payload called the "Getaway Special" was received, processed, and installed in the Columbia in preparation for STS-3 flight. The prototype, named the Verification Canister, contains instrumentation for measurement of temperature, vibration, noise, and pressure these payloads will experience in the cargo bay on future flights.

Integrated systems tests of Multi-use Mission Support Equipment (canister and transporter) were completed in early 1981 and the equipment was utilized for processing of OSTA-1 into STS-2 and OSS-1 into STS-3.

Significant events planned for cargo processing in 1982 are as follow:

1. Processing of Department of Defense 82-1 cargo through the Vertical Processing Facility to support STS-4.
2. Payload Assist Module and Inertial Upper Stage (PAM and IUS) Pathfinders will be processed through the various facilities to validate equipment and procedures.
3. Processing of STS-5 cargo: The cargo includes the TELESAT and SBS -- the first commercial payloads to fly on STS. These two spacecraft will utilize the PAM-D (commercially developed assist module) as an upper stage to accomplish synchronous orbit.
4. Processing of STS-6 cargo. The cargo includes the Tracking and Data Relay Satellite (TDRS). The final synchronous orbit will be accomplished by use of the IUS (developed by the Air Force).
5. Acceptance of Spacelab Flight Unit #2, Igloo and its Pallets, in Europe and receipt at KSC.
6. Processing of Spacelab Flight Unit #1 experiment and flight hardware.

Life Sciences

A comprehensive Life Sciences Support Facility has recently been completed at Hangar L at Cape Canaveral Air Force Station. This provides a large (24,000

sq. ft.) and up-to-date capability for support of Life Sciences animal and plant flight experiments and also for in-house life sciences activities. The first "experiment in residence" is a hydrogen production from biological sources study.

In this same area, our physiological stress laboratory has received recognition and funding from Headquarters Division of Life Sciences for further studies. We already are conducting studies in the physiological stresses for both men and women in some of our more physically strenuous and demanding operational activities. The long range objective is projection of information on current requirements for spacecraft preparation into the coming era of "in orbit preparation." It was also this laboratory which made the first quantitative physiological assessments of NASA and Air Force SCAPE Suits (Self-Contained Atmospheric Protective Ensembles) and established the physiological acceptance criteria for a new generation of suits now in development.

KSC STS Facilities and Ground Support Equipment

Damage to facilities from launch of STS-1 and 2 was minor. Hardening of various launch pad and mobile launcher platform areas for the STS-2 launch reduced damage to less than half that sustained in STS-1.

Work on the second line of STS facilities is proceeding, with no significant schedule problems foreseen.

Payload facilities for STS were initiated with the Fiscal Year 1977 Construction of Facilities (CofF) project to modify the Operations and Checkout (O&C) Building for horizontal payload processing. The project has been completed. A Fiscal Year 1978 project for the Vertical Processing Facility (VPF) followed. The basic VPF has been completed, with construction of an operations support building nearing completion. Rehabilitation and Modifications for Payload Ground Support Operations included in the FY 1981 and FY 1982 CofF

programs currently are being worked and are scheduled to be ready to support payload requirements.

The Fiscal Year 1983 CofF projects are entering the design stage, e.g., an expansion of the SRB Refurbishment and Subassembly facility. Also, modifications of the Operations & Checkout Building for payload ground support operations are in design. These modifications provide for a Baseline Data Collection Facility, a signal acquisition room and a third payload users room.

Expendable Launch Vehicles

KSC had another active year in the Expendable Vehicles Program in 1981 with nine launches, two of which were from the Western Space and Missile Center (WSMC). Six communications spacecraft, a weather satellite, a solar research satellite and an atmospheric explorer satellite were launched into orbit during 1981.

A chronological summary of the year's launches follows:
February 21 - COMSTAR-D, the fourth spacecraft in this series of domestic commercial communications satellites used primarily for long distance telephone service within the United States, was launched by an Atlas-Centaur from Complex 36.
May 22 - The weather observing satellite GOES-5 (Geostationary Operational Environmental Satellite) was launched on a Delta from Complex 17.
May 23 - The second in a series of INTELSAT V spacecraft that provide a high quality and reliable worldwide satellite telecommunications system was launched on an Atlas-Centaur from Complex 36.
August 3 - Two atmospheric research satellites (Dynamic Explorer A/B) were launched in tandem on a Delta from the Western Space and Missile Center.
August 6 - FLTSATCOM-E, the fifth in a series of military communications satellites was launched on an Atlas-Centaur from Complex 36. A mission failure occurred after achieving orbit and presently is under investigation.

September 24 - Satellite Business Systems-2 (SBS-2), the second in a series of spacecraft designed exclusively for business-to-business communications, was launched aboard a Delta from Complex 17.
October 6 - The solar research satellite SME (Solar Mesosphere Explorer) was launched from the Western Space and Missile Center on a Delta into a near circular polar orbit.
November 19 - RCA-D, the fourth spacecraft in a series of domestic communications satellites, was launched on a Delta from Complex 17.
December 15 - The second INTELSAT V of the year and third in the series of communications satellites was launched atop an Atlas-Centaur from Complex 36.
1982 promises to be another busy year with 10 launches scheduled, using three Atlas-Centaur and 7 Delta vehicles. All launches, with the exception of an earth resources satellite (Landsat-D) from the Western Space and Missile Center on a Delta, will be communications satellites launched from the Eastern Space and Missile Center.

Public Affairs

1981 saw a dramatic increase in Public Affairs activities at the Center, most of which can be directly attributed to the public interest in the Space Shuttle. At our public Visitor Center, we accommodated more than two million tourists. While attendance at most Florida attractions was down or barely even with the previous year, at KSC our public bus tour showed a 25 percent increase over 1980.

TWA Services, our concession contractor at the Visitor Center, is forging ahead with a planned $8 million expansion to better tell the NASA story to the increasing number of visitors.

For the first launch attempt of STS-1, the Center was inundated with 80,000 guests, including news media, distinguished officials from our own government as well as foreign countries, business leaders, and the general public. The resulting massive traffic jams on the Center were alleviated considerably for the second launch attempt when we had both fewer visitors and an improved traffic plan. On the second launch, we pared down the number of invitees. The event was witnessed from KSC by about 22,000 enthusiastic viewers.

Interest continues at a very high level, and we plan to continue to issue invitations for the coming launches this year at about the same level issued for STS-2.

Later this year, we expect the first landing to take place at KSC; and that will draw a great deal of interest from the news media and the public. The Shuttle Landing Facility is nestled among the trees on North Merritt Island, so the actual touchdown cannot be viewed from the roadways. We have built a viewing mound which will accommodate approximately 4,000 people at the mid-point of the runway. That number will be divided between distinguished guests and the media. We are looking at some of the roadways to see where else on the Center we can accommodate visitors who would like to witness the approach even though they cannot see touchdown.

Fiscal Year 1982 Budget

KSC is operating with a $617.2M plan for fiscal year 1982. Space Transportation System is funding $324.2M for the Space Shuttle; $2.2M for Expendable Launch Vehicles; and $104.9M for Space Flight Operations, which includes Development Test and Mission Support at $64.4M; Upper Stages at $1.8M; and $38.7M for Payload Support, Operations and Studies.

The balance of our R&D effort is in the fields of Physics and Astronomy, $1.2M; Life Sciences, $0.9M, and Technology Utilization, $0.1M.

The KSC Construction of Facilities plan calls for $20.3M in Fiscal Year 1982. Shuttle facilities account for $15.5M; institutional projects $2.2M; $2.4M for rehabilitation and modification and $0.2M for minor construction projects. Research and program management funding for Fiscal Year 1982 is $163.4M. Of these funds, $84.2M is for civil service personnel pay and related costs; $1.7M for travel and $77.5M for Center operations.

Manpower

At the end of FY81, KSC's total population was 14,000, consisting of 2,277 Federal employees, 10,167 contractor employees, and 1,556 tenant employees.

Civil service retirements remain a concern, however, we continue to make maximum use of our limited hiring capability to bring new college graduates into our work force. Through this effort, we have been able to slow our average age increase considerably. Our average age actually decreased during FY80 from 44.9 to 44.8. However, we had a slight increase during FY81 to 45.2. Our goal is to maintain a growth rate of .5 or less per year.

This completes my statement on the status of activities at the John F. Kennedy Space Center.

1983 NASA AUTHORIZATION

TUESDAY, FEBRUARY 9, 1982.

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS;
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,
Washington, D.C.

The committee met, pursuant to notice, at 10:05 a.m., in room 2318, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the Subcommittee on Space Science and Applications), presiding.

Present: Representatives Flippo, Glickman, Fuqua, Brown, Nelson, Shamansky, Hollenbeck, Winn, McGrath, Dunn, and Lowery.

Staff present: Darrell Branscome, staff director, Subcommittee on Space Science and Applications; Tony Taylor, staff director, Subcommittee on Transportation, Aviation and Materials; and Jeff Irons, minority technical consultant.

Mr. FLIPPO. The subcommittee will come to order.

STATEMENT OF HON. RONNIE G. FLIPPO, A MEMBER OF CONGRESS FROM THE STATE OF ALABAMA, AND CHAIRMAN, SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS, COMMITTEE ON SCIENCE AND TECHNOLOGY

Mr. FLIPPO. Today the Subcommittee on Space Science and Applications and the Subcommittee on Transportation, Aviation and Materials begin a series of hearings on the NASA fiscal year 1983 budget request. We want to welcome the NASA Administrator, the Honorable James M. Beggs, and the Deputy Administrator, Dr. Hans Mark. We look forward to their presentation of the 1983 budget.

From the press reports of the threats to the NASA programs which occurred during the budget formulation process, congratulations are certainly in order for your success in achieving the budget level which has been proposed. However, the proposed fiscal year 1982 operating plan and the fiscal year 1983 budget request raise concerns with regard to balance across disciplines of space science, applications, and aeronautics and with regard to balance of program thrust between civil and military activities.

The fiscal year 1982 operating plan makes little more than token consideration of program augmentations provided for in the fiscal year 1982 Authorization and Appropriation Acts. There is particular concern about the inclusion of new program activities in

NASA's plan while at the same time the plan largely ignores the aforementioned program augmentations.

This administration is not alone in its failure to provide a proper program balance. Perhaps it is useful to again review commitments or lack of commitments, as it turns out, by successive administrations over the past decade.

When the Shuttle was presented to the Congress in the early 1970's we were told that NASA would maintain a level budget corrected for inflation. We all know that that has not been the case.

In the mid-1970's, when the administration proposed that all production orbiters would be funded in the NASA budget, we were led to believe that the funds for the Air Force orbiters would be provided to NASA over and above the NASA ongoing programs. However, NASA has had to absorb these costs, resulting in ever-increasing reductions and deferrals of high priority space science and applications programs.

These broken commitments reflect a lack of understanding on the part of successive administrations of the important contributions which our space program makes to our economy, to an improved standard of living, to our standing among the peoples of the world, to international cooperation, and to the solutions of many of our most pressing problems such as energy, natural resources, environment, and food supplies.

As time passes, we must become ever more concerned that NASA will operate a space freighter but perhaps be unable to develop its own freight. Perhaps it is time that when we are asking civil mission agencies to share greater responsibility in technology demonstrations having civil application we should also ask the Department of Defense to assume a larger role in technology demonstrations having military application.

In the 1970's much of our space program has been focused on the development of the Space Shuttle. We recognize the importance of the space transportation system and the need to maintain production delivery schedules and flight rates for both civil and military utilization.

During the 1970's we have also witnessed the development of remote sensing technology for surveying Earth resources from space. However, with the de-emphasis of the space applications program both in terms of organizational status as well as reductions in resources, we must be concerned that our Nation will not exploit our leadership not only for national benefit but for the benefit of the developing world.

With regard to planetary exploration, rarely has such a successful enterprise been threatened with extinction by the Nation's science policy leaders so soon after remarkable achievements such as the Voyager missions to Jupiter and Saturn.

Press reports of NASA internal memoranda outlining a future agency direction of increasing emphasis in military technology raises additional concerns. The National Aeronautics and Space Act of 1958 provides for independent civil and defense programs with, however, shared information and technology, shared launch vehicles, and, where appropriate, cooperative programs.

De-emphasizing efforts on civil space applications and increasing emphasis on military space applications technology as outlined in

this memoranda is clearly in conflict with the Space Act and contradicts congressional intent and direction over two decades.

We must recognize not only NASA's contribution to national defense but also NASA's contribution to our national economy. Indeed, only through a strong economy and successful competition in the international marketplace can we sustain a strong defense program.

Therefore, we as a Nation must continue to make the incremental investment necessary to strengthen and increase commercial aerospace sales through exploitation of space and aeronautical technology having both civil and military applications. The existence of an open space and aeronautics program conducted by NASA contributes significantly to this end.

Perhaps my congratulations on the level of the budget request in concert with the number of concerns I have raised are indicative of the difficult times we are in. Hopefully the funding level represents an increased understanding by this administration of the positive contributions which the NASA programs can make to national defense, the Nation's economy, monitoring and detection of our natural resources, and the expansion of scientific knowledge.

We are indeed pleased by the administration's personal support of the space program evidenced by the President's visit to mission control and the Vice President's participation in the space lab acceptance ceremony. We certainly commend their support to what we consider a most worthwhile Federal activity. We are also pleased by the Vice President's words of support for vigorous international cooperation in space.

At this time I would like to recognize the ranking minority member from New Jersey, Mr. Hollenbeck.

STATEMENT BY HON. HAROLD C. HOLLENBECK, A MEMBER OF CONGRESS FROM THE STATE OF NEW JERSEY

Mr. HOLLENBECK. Thank you, Mr. Chairman.

I too am looking forward to Mr. Beggs' testimony before our subcommittees today. I also welcome you, Dr. Mark.

NASA's budget request of just over $6.6 billion for fiscal year 1983 represents an 11-percent increase over the revised operating plan for 1982. However, I ask whether this budget will guarantee the continued success of the civilian space program. Of the $5.3 billion requested for research and development, $3.5 billion has been designated for the space transportation system. Are we going to be able to fund the various activities at NASA that fully support the objectives outlined in the 1958 Space Act with the remaining $1.8 billion?

I am concerned with the recent decisions to not go ahead with the flight demonstration of the 30/20 gigcheta satellite, nor to fund the Venus orbiting imaging radar, and by expecting industry to pick up the various technology transfer activities previously performed by NASA, we may be starting on a downward spiral which may lead to technology stagnation.

Projects like the Galileo mission to Jupiter, the Space Telescope, ISPM, and most assuredly the Space Shuttle are not only good for the sake of science but spinoffs from these different programs will

and do eventually find their way into our daily lives. Each one of us will realize a return of three to seven times our initial investment in space tax dollars.

In light of recent budget reductions there have been a number of published reports about the private sector financing the fifth space shuttle orbiter in return for marketing rights of foreign and commercial payloads for the entire space transportation system.

I personally talked to a number of people on this topic. I understand there is a forthcoming proposal from one such company to be submitted to NASA, possibly within several months. Because of the timely and I think interesting nature of the matter, possibly Mr. Beggs or Dr. Mark would like to comment briefly on the feasibility of such a proposal.

From my discussions I have also learned that time may be of the essence. If such is the case, I wonder in what timetable, if any, should the subcommittee expect to consider legislative initiates to amend the existing Space Act, but perhaps that is a subject for later consideration.

All members of both subcommittees hope that NASA can continue the work that has moved the agency to its international preeminence as a leader in the aerospace sciences. We do not want to see technology stifled for the sake of a few dollars. It is essential for the United States to have a strong civilian space program and I hope this will continue to be the goal of the administration.

Thank you.

Mr. FLIPPO. The distinguished chairman of the Subcommittee on Transportation, Mr. Glickman?

STATEMENT OF HON. DAN GLICKMAN, A MEMBER OF CONGRESS FROM THE STATE OF KANSAS, AND CHAIRMAN, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS, COMMITTEE ON SCIENCE AND TECHNOLOGY

Mr. GLICKMAN. Thank you, Mr. Flippo.

I would also like to welcome Mr. Beggs and Dr. Mark.

As the chairman of the Subcommittee on Transportation, Aviation, and Materials, in addition to the discussion raised by Mr. Hollenbeck and Mr. Flippo, I am particularly interested in the issue of aviation.

I hardly need remind this audience of the very sizable contribution to our national economy made by the American aircraft industry. Nor do I need to underscore the fact that this contribution is in large measure due to the long standing partnership of Government and industry in developing new technology. The U.S. aeronautics community has a lead in the world primarily because its products are technically superior to the offerings of non-U.S. companies. Unquestionably the research activities of NACA and NASA have been pivotal.

The winners of the future markets within aviation will be the companies that have the best technical solutions to the pressing problems including fuel efficiency, lower noise, lower operating costs, pilot dispatch reliability, and increased safety. Yet in spite of the obvious cost-effectiveness of this arrangement, the administration has decided to take a radically different approach. Starting

with the recently released fiscal year 1982 operating plan and culminating in this budget request, you have totally disengaged from systems technology work aimed at civil aviation while continuing primarily those items only of interest to the military.

As I have indicated, these programs are of immense value. Such projects as the advanced turbo-prop and large scale composites would have saved the airlines and the Nation millions of gallons of fuel. However, they have all been axed, not only for 1983 but, as I look at the numbers, for fiscal year 1982. I am concerned about it. I think the U.S. aviation industry ought to be concerned about it. I think those who are interested in our national economy ought to be concerned about it.

I think it is exactly the wrong thing to do. Our foreign competitors have concluded that their best shot at the worldwide market was to emulate our system. They are having considerable success at doing so. Why are we ready to junk something that has served us so well for so long?

Since our Government cannot control how Japan or Germany or England spend their money and since import restrictions are not a satisfactory solution, the most effective approach is to provide the U.S. aviation industry with the technical support that will result in technologically superior products. Obviously such technical support can come only from authorizing a strong aeronautics program within NASA.

I do not mean to be harsh with you, Mr. Beggs, or you, Dr. Mark, because I know of your submissions to the Office of Management and Budget in a broad variety of systems technology work from fuel economy to structures to a broad variety of other things intended to continue the programs of NASA over the last previous years. However, what came back from OMB in my judgment represented a dramatic change in the role this Government is going to have with respect to aeronautics.

One final point: The other subject that concerns me is your support to the Department of Energy, particularly for certain transportation programs such as the heat engine program. I understand from your statement that you contemplate withdrawing from this kind of assistance to the Department of Energy. This action may in fact be consistent with administration proposals to terminate these programs, but if Congress does not concur and continues the funding for these programs I hope you will reconsider.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

We are pleased to have the full committee chairman and former subcommittee chairman of this Subcommittee on Space Science and Applications, a man who has provided great leadership for many years in this area, Chairman Fuqua, with us today.

STATEMENT OF HON. DON FUQUA, A MEMBER OF CONGRESS FROM THE STATE OF FLORIDA, AND CHAIRMAN, COMMITTEE ON SCIENCE AND TECHNOLOGY

Mr. FUQUA. Mr. Chairman, I do not have a formal statement to make. I do want to welcome the Administrator and Deputy Admin-

istrator. I think this is the first occasion that they have been before this committee in their present capacity. I want to welcome you.

I think by the statements that have been made you can see the concern we all have that we continue to move forward for the peaceful uses of space and aeronautics. I am sure in the course of the hearings and in the debates in the House and Senate that these concerns will be further expressed.

Again, I welcome you here and look forward to working with you throughout the year.

Mr. FLIPPO. I am also pleased to note the presence of a distinguished gentleman from Kansas, the ranking minority member of the full committee and a member of the Subcommittee on Space Science and Applications for a number of years, who has also provided great leadership, Mr. Winn?

STATEMENT OF HON. LARRY WINN, JR., A MEMBER OF CONGRESS FROM THE STATE OF KANSAS

Mr. WINN. Thank you, Mr. Chairman.

I too want to welcome Mr. Beggs and Dr. Mark. I hope that you two gentlemen do not feel too badly bruised already by some members of the committee in their enthusiasm to see that the United States remains No. 1 in space technology. I know that this is behind their questions and line of thinking. I would like to point out that it seems that a couple of members did forget that some of the programs they mentioned were not funded in the last 4 years under their administration either.

In our enthusiasm and in our dedication—I do not question that on the part of any member on either side of the aisle—as I think Mr. Glickman did remark that certain figures did go down to OMB, it is hard for members of this committee to realize that those cuts are going to be made and that you had to decide on the priorities. We have sat here for years and years and worked on the program that is taking most of our money, the Space Shuttle. We cannot have everything that we can think of and everything that we would like to have. I am looking forward to your testimony.

Thank you very much, Mr. Chairman.

Mr. FLIPPO. Thank you, Mr. Winn.

Are there other members who would care to be recognized at this time?

Mr. NELSON. Mr. Chairman?

Mr. FLIPPO. Mr. Nelson?

STATEMENT OF HON. BILL NELSON, A MEMBER OF CONGRESS FROM THE STATE OF FLORIDA

Mr. NELSON. I just want to say, Mr. Chairman, that I want to congratulate the Administrator and the Deputy Administrator for presenting their case most effectively down in the OMB kitchen as they were starting to slice up the pie. Apparently the persuasiveness and the articulation of these two gentlemen found its mark in that they were able to get a little bit larger slice of the pie even though it might be characterized as a sort of damaged control situation.

I welcome you all and I thank you for the effectiveness that you both have demonstrated.

Mr. FLIPPO. The gentleman from New York, Mr. McGrath?

STATEMENT OF HON. RAYMOND J. McGRATH, A MEMBER OF CONGRESS FROM THE STATE OF NEW YORK

Mr. MCGRATH. Thank you, Mr. Chairman, and welcome, Mr. Beggs and Dr. Mark.

In your testimony I would hope that perhaps you could address the difference between the NASA authorization as proposed by this particular subcommittee last year and the changes that were made in the operating plan for 1982. Some of us are a little disturbed about the manner in which some of those decisions were made. Some of the programs which we felt were important were either eliminated or scaled down. Perhaps you could also address the issue in the budget as far as the upper stage versus Centaur goes.

We are glad to have you here. I am looking forward to a very long and intense hearing.

Mr. FLIPPO. Mr. Beggs, we would be pleased to have your testimony. We will include the entire statement in the record following your presentation. Please feel free to proceed as you deem appropriate.

STATEMENT OF JAMES M. BEGGS, ADMINISTRATOR, NASA; ACCOMPANIED BY DR. HANS MARK, DEPUTY ADMINISTRATOR, NASA; AND THOMAS NEWMAN, COMPTROLLER, NASA.

Mr. BEGGS. Thank you, Mr. Chairman.

In addition to the Deputy Administrator, Dr. Hans Mark, I have Mr. Tom Newman, the Comptroller of the Agency accompanying me. I also have a number of my colleagues sitting behind me. With your permission, sir, as we proceed, I will call upon them to talk about areas of their expertise.

Mr. Chairman and members of the subcommittee, it is my pleasure to appear today as well as my first opportunity to appear before you on budget matters. It has been an unusual year for all us, I believe, in this budget exercise; but, we feel that the budget request we are presenting today for fiscal year 1983, a request of $6.613 billion of which $5.334 billion is for research and development, $100 million for construction of facilities, and $1.179 billion for research and program management, is a budget that is a good one for the Agency and one with which we can live very well.

During his first year in office, the President has clearly stated the two major policy priorities of the administration. The first is to revive our economy and the second is to strengthen our national security. The control of inflation has been identified as this administration's primary economic objective. Since inflation is related to spending by the Government, the total request, as submitted, reflects significant steps to reduce spending in fiscal year 1983. At the same time, the military and political threat posed by the Soviet Union has increased steadily during the past two decades. Improving the Nation's defense posture is clearly the second major priority of the administration.

Before turning to the details of our request, I would like to review the significant contributions and challenges which I foresee for the Agency in the coming year.

The United States has conducted a vigorous space program for almost a quarter century under the broad policy guidelines set by the Congress in the National Aeronautics and Space Act of 1958. This farsighted piece of legislation has made it possible to conduct a program in both the public and private sectors that has led to truly remarkable scientific and technical achievements and to an ever-increasing investment in terms of real dollars in aviation and space operations.

The large commercial communications satellites now in geostationary orbit are the direct technical descendents of NASA's early applications technology satellites. The relative stability of the world today is dependent to a considerable extent on national security related satellites employing technology that was pioneered by NASA in the 1950's and 1960's.

The success of this technology transfer to the commercial and military sectors is demonstrated by the fact that NASA today accounts for a smaller fraction of the national spending on space-related activities than in the past even though the NASA budget has remained relatively constant in real year dollars for the past few years. The national security related space program and the commercial programs have both seen very substantial increases in the past 5 years. These increases are related to important national security requirements as well as new commercial opportunities. The ability to satisfy these requirements and to exploit these opportunities is due in large measure to the work performed by NASA over the years.

In accord with the administration's policies, NASA's fiscal year 1983 program shows the retention of, or increases in, those programs that can be directly related to national security. We have also maintained a strong program in those fields directly related to the responsibilities of NASA in the Space Act. However, some programs have been reduced or delayed because of the urgent need to reduce Federal spending. I have heard expressions of concern that this balance of priorities can lead to the militarization of the Agency. I would like to assure you, Mr. Chairmen, that this administration is strongly committed to the maintenance of an independent NASA charged with pioneering new enterprises and technologies that will enhance the ability of the United States to conduct operations in space and aeronautics that further the objectives laid out in the National Aeronautics and Space Act and maintain the competitive posture of the country in both aeronautics and space technology.

The past year was a historic one for the development of new capabilities in space. The first flight of Columbia in April was a milestone that marks a fundamental change in the way space operations will be conducted in the future. The second flight in November was the first time that a spacecraft has been reused in its entirety—flown again and recovered. The original concept of a reusable spacecraft that was developed by NASA in the late 1960's has therefore been proven and the Nation can be justifiably proud of this achievement.

We have fully funded the important elements of the Shuttle program in the fiscal year 1983 request. The highest priority we have set for NASA is to complete the development of the Shuttle and to turn it into an operational system. Safety and reliability of flight and the control of operational costs are primary objectives as we move forward with the Shuttle program. We are continuing to take the necessary technical and management steps to make certain that safety will not be compromised and that reliability will exceed that of our current generation of launch vehicles. Cost control is equally important to the viability of the system. This aspect is sharpened by the serious competition for launch services that we now face from abroad. This is a very real competitive pressure.

The steps which we shall take to control the cost of Shuttle operations will fall into two broad categories. First, we intend to reduce the number of people necessary to conduct shuttle operations. We believe this can be accomplished through a number of incremental steps without compromising safety and reliability as we gain flight experience. We plan to make a careful analysis of the actions which we must carry out to plan and conduct shuttle operations. This analysis will include requirements and procedures for flight planning, payload integration, vehicle servicing, test and checkout. We will then be in a position to streamline our civil service and contractor structures to match those requirements.

Second, we must reduce the cost of producing the consumable items used for each flight and of refurbishing the items that are reused from flight to flight. The external fuel tanks are perhaps the best example of what we have in mind. We believe that substantial production cost reductions are possible as we make necessary investments to automate production procedures. In other areas I expect flight experience to lead to design changes which will permit operational cost savings.

We have made some significant program reductions in various areas in order to help meet the administration's objective of fighting inflation by reducing Federal spending. These reductions have been made in those portions of our aeronautics and space applications programs where we believe it appropriate for the private sector of our economy to play a larger role. It is important to recognize that we have not reduced spending on basic research and technology that could support new initiatives in civil aviation or in space applications. What we have done is to reduce our work in systems technology and in technology demonstration programs in which performance by the private sector appears appropriate.

We have also reduced some of our activities in space science and space exploration. In making these reductions, we have placed the highest priority on work in astronomy and space physics because we believe that discoveries of an unusually important and fundamental nature will soon be forthcoming. We have, therefore, funded both the Space Telescope and the Gamma Ray Observatory. There is good reason to believe that the Space Telescope, to be launched in 1985, will be the most important scientific instrument ever flown.

We have retained the Gamma Ray Observatory for launch in 1988 for the same reason. Gamma rays are probably the most sensitive indicators of what happens in objects where very energetic

processes are occurring. We have made some reductions in our planetary exploration program, most significantly deletion of the Venus orbiting imaging radar mission, but we have retained funds for the Galileo mission. The planetary program realized enormous success in the past decade. We believe, however, the time has come to reevaluate this program and to set new directions for the future. Several scientific study groups within and outside of NASA are now studying the future of the planetary exploration program. We believe that the outcome of these studies could lead to the development of some less expensive missions for the late 1980's and early 1990's as well as more ambitious concepts such as manned visits to the Earth-crossing asteroids and perhaps the nearby planets in the years to follow.

As noted earlier, the policies which the administration is developing to shape the future of the American space and aeronautics program, are consistent with the National Aeronautics and Space Act. They provide for the retention of two administratively separate activities in space, one related to the national security and the other related to essentially civilian activities. While this separation is maintained, we are working actively to strengthen relationships at all levels between NASA and those elements of the national defense establishment for activities in space related to the national security. You will see evidence of this when you examine the details of our program. We strongly support this administrative separation and believe that the arrangement has served the national interest well in the past and will continue to do so in the future.

A fundamental requirement of the Space Act is to preserve the role of the United States as a leader in space technology. For the last decade, the major policy objective of the space program has been to provide routine access to space. To implement this policy objective, we have created the Space Shuttle. Although we still have much work to do to turn the shuttle into an operational system, we believe the time has come to examine some possible new policy objectives and to plan the technological initiatives required to implement them. For example, an operational Space Shuttle leads to the possibility of establishing permanent facilities and a permanent presence in space. We are critically examining the possibility of establishing a permanent presence in space as a major national initiative in space and have begun appropriate discussions within the administration.

Several other policy and institutional issues are currently under review by study groups organized under the auspices of the Office of Science and Technology Policy. These include studies dealing with the institutional arrangements in aeronautics and in Space Shuttle operations and with technical questions concerning the stable of launch vehicles that the Nation's space operations will require in the future. We expect that these studies will be completed in the late spring or summer of this year. NASA is well represented and deeply involved in those studies.

Finally, I would like to say a word about the NASA organization. In the past 6 months, we have made some operational changes that will hopefully make it easier for me to spend more time on the major policy questions that I have just outlined. We have improved communications and streamlined overall management control by

reducing the number of people who report directly to me. We have consolidated the Offices of Space Science and Space Applications into one organization to strengthen the common technical and management elements inherent in the previously separate organizations. We have broadened the authority and responsibilities of the program associate administrators by having the field centers report directly to them rather than to me. I believe the organizational steps we have thus taken will make it possible to delegate authority more readily and improve the overall operation of the organization.

Mr. Chairmen, that concludes my oral statement. With your permission, I will submit the entire statement for the record.

[The prepared statement, plus answers to questions asked of Mr. Beggs, follow:]

HOLD FOR RELEASE
UNTIL PRESENTED
BY WITNESS
FEBRUARY 9, 1982

Statement of

James M. Beggs
Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
and the
Subcommittee on Transportation, Aviation and Materials
House of Representatives

Mr. Chairmen and Members of the Subcommittees:

It is a pleasure to appear today to present President Reagan's budget request for NASA for Fiscal Year 1983. The total request is $6.613 billion of which $5.334 billion is for Research and Development, $100 million is for Construction of Facilities, and $1.179 billion is for Research and Program Management. A chart summarizing the request is appended to this statement.

During his first year in office, the President has clearly stated the two major policy priorities of the Administration. The first is to revive our economy and the second is to strengthen our national security. The control of inflation has been identified as this Administration's primary economic objective. Since inflation is related to spending by the government, the total request, as submitted, reflects significant steps to reduce spending in FY 1983. At the same time, the military and political threat posed by the Soviet Union has increased steadily during the past two decades. Improving the Nation's defense posture is clearly the second major priority of the Administration. The FY 1983 budget request for the National Aeronautics and Space Administration has been prepared to be consistent with these broad and over-riding priorities.

Before turning to the details of the request, I would like to review the significant contributions and challenges which I foresee for the Agency in the coming fiscal year.

The United States has conducted a vigorous space program for almost a quarter century under the broad policy guidelines set by the Congress in the National Aeronautics and Space Act of 1958. This far-sighted piece of legislation has made it possible to conduct a program in both the public and private sectors that has led to truly remarkable scientific and technical achievements and to ever-increasing investments in terms of real dollars in aviation and space operations.

The large commercial communications satellites now in geostationary orbit are the direct technical descendents of NASA's early Applications Technology Satellites. The relative stability of the world today is dependent to a considerable extent on national security related satellites employing technology that was pioneered by NASA in the 1950's and 1960's. The success of this technology transfer to the commercial and military sectors is demonstrated by the fact that NASA today accounts for a smaller fraction of the national spending on space-related activities than in the past even though the NASA budget has remained relatively constant in real year dollars for the past few years. The national security related space program and the commercial programs have both seen very substantial increases in the past five years. These increases are related to important national security requirements as well as new commercial opportunities. The ability to satisfy these requirements and to exploit these opportunities is due in large measure to the work performed by NASA over the years.

In accord with the Administration's policies, NASA's FY 1983 program shows the retention of, or increases in, those programs that can be related directly to national security. We have also maintained a strong program in those fields directly related to the responsibilities of NASA under the National Aeronautics and Space Act. However, some programs have been reduced or delayed because of the urgent need to reduce federal spending. We have heard expressions of concern that this balance of priorities can lead to the "militarization" of the agency. I would like to assure you, Mr. Chairmen, that this Administration is strongly committed to the maintenance of an independent NASA charged with pioneering new enterprises and technologies that will enhance the ability of the United States to conduct operations in space and aeronautics that further the objectives laid out in the National Aeronautics and Space Act and maintain the competitive posture of this country in aeronautics and space technology.

We are conducting our support of agencies with responsibilities in the area of national security under the provision of the Act that requires NASA to make "available to agencies directly concerned with national defense of discoveries that have military value or significance....."(Section 102(c)(6)). The case of aeronautics is a particularly important example. The President, in submitting his strategic force modernization program to the Congress in October 1981, has made commitments in excess of $50 billion for the next decade to create a new generation of strategic aircraft. The B-1B bomber, a variation of the B-1 configuration, has already benefited heavily from NASA support in the design process. A large fraction of the 26,000 hours of wind tunnel time used to develop the B-1 configuration was performed in NASA facilities. We expect to provide comparable support in other defense-related areas such as advanced avionics and the so-called "stealth" technologies. NASA's aeronautics program has been structured to provide full support for those aeronautical programs that are vital to the national security as well as the high priority needs of the commercial aeronautics programs.

The past year was a historic one for the development of new capabilities in space. The first flight of "Columbia" in April was a milestone that marks a fundamental change in the way space operations will be conducted in the future. The second flight in November was the first time that a spacecraft has been reused in its entirety - flown again, and recovered. The original concept of a reuseable spacecraft that was developed by NASA in the late 1960's has therefore been proved and the nation can be justifiably proud of this achievement.

We have fully funded the important elements of the Shuttle program in our FY 1983 request. The highest priority we have set for NASA is to complete the development of the Shuttle and to turn it into an operational system. Safety and reliability of flight and the control of operational costs are primary objectives as we move forward with the Shuttle program. We are continuing to take the necessary technical and management steps to make certain that safety will not be compromised and that reliability will exceed that of our current generation of launch vehicles. Cost control is equally important to the viability of the system. This aspect is sharpened by the serious competition for launch services that we now face from abroad.

The steps which we shall take to control the cost of Shuttle operations will fall into two broad categories: first, we will reduce the number of people necessary to conduct Shuttle operations. We believe that this can be accomplished through a number of incremental steps, as we gain flight experience, without compromising safety and reliability. We plan to make a careful analysis of the actions which we must carry out to plan and conduct Shuttle operations. This analysis will include requirements and procedures for flight planning, payload integration, vehicle servicing, test and checkout. We will then be in a position to streamline our civil service and contractor structures to match those requirements. Second, we must reduce the cost of producing the consumable items used for each flight and of refurbishing the items that are reused from flight to flight. The external fuel tanks are perhaps the best example of what we have in mind. We believe that substantial production cost reductions are possible as we make necessary investments to automate production procedures. In other areas I expect flight experience to lead to design changes which will permit operational cost savings.

We have made some significant program reductions in various areas in order to help meet the Administration's objective of fighting inflation by reducing federal spending. These reductions have been made in those portions of our aeronautics and space applications programs where we believe it is appropriate for the private sector of our economy to play a larger role. It is important to recognize that we have not reduced spending on basic research and technology that could support new initiatives in civil aviation or in space applications. What we have done is to reduce our work in systems technology and in technology demonstration programs in which performance by the private sector appears appropriate.

We have also reduced some of our activities in space science and space exploration. In making these reductions, we have placed the highest priority on work in astronomy and space physics because we believe that discoveries of an unusually important and fundamental nature will soon be forthcoming in these important areas. We have therefore funded both the Space Telescope and the Gamma Ray Observatory. There is good reason to believe that the Space Telescope, to be launched in 1985, will be the most important scientific instrument ever flown. Observation of objects such as quasars, Seyfert Galaxies, and the remnants of large supernova events will almost certainly lead to new information about the origin of the universe.

We have retained the Gamma Ray Observatory for launch in 1988 for the same reason--because gamma rays are probably the most sensitive indicators of what happens in objects where very energetic processes are occurring. We have made some reductions in our planetary exploration program, most significantly, deletion of the Venus Orbiting Imaging Radar mission, but we have retained funds for the Galileo mission in the FY 1983 request. The planetary program realized enormous success in the last decade. We believe, however, the time has come to reevaluate this program and to set new direction for the future. Several scientific study groups within and outside NASA are now studying the future of the planetary exploration program. We believe that the outcome of these studies could lead to the development of some less expensive missions for the late 1980's and early 1990's as well as more ambitious concepts such as manned visits to earth-crossing asteroids and perhaps the nearby planets in the years to follow.

As noted earlier, the policies the Administration is developing to shape the future of the American space and aeronautics program are consistent with the National Aeronautics and Space Act. They provide for the retention of two administratively separate activities in space--one related to the national security and another related to essentially civilian activities. While this separation is maintained, we are working actively to strengthen relationships at all levels between NASA and those elements in the national defense establishment for activities in space related to the national security. You will see evidence of this when you examine the details of our program. We strongly support this administrative separation and believe that the arrangement has served the national interest well in the past and will continue to do so in the future.

A fundamental requirement of the Space Act is to preserve the role of the United States as a leader in space technology. For the last decade the major policy objective of the space program has been to provide routine access to space. To implement this policy objective we have created the Space Shuttle. Although we still have much work to do to turn the Shuttle into an operational system, we believe that the time has come to examine some possible new policy objectives and to plan the technological initiatives required to implement them. For example, an operational Space Shuttle leads to the possibility of establishing permanent facilities and a permanent presence in space. We are critically examining the possibility of establishing a permanent presence in space, as a major national initiative in space and have begun appropriate discussions within the Administration to this end.

Several other policy and institutional issues are currently under review by study groups organized under the auspices of the Office of Science and Technology Policy. These include studies dealing with institutional arrangements in aeronautics and in Space Shuttle operations and with technical questions concerning the stable of launch vehicles that the Nation's space operations will require in the future. We expect that these studies will be complete in the late spring or summer of this year. NASA is well represented and deeply involved in these studies and we believe they will provide a new insight into the national aeronautics and space endeavor.

Finally, I would like to say a word about the NASA organization. In the past six months we have made some organizational changes that will hopefully make it easier for me to spend more time on the major policy questions that I have just outlined. We have improved communications and streamlined overall management control by reducing the number of people who report directly to me. We have consolidated the Offices of Space Science and Space Applications into one organization to strengthen the common technical and management elements inherent in the previously separate organizations. We have broadened the authority and responsibilities of the Program Associate Administrators by having the field centers report directly to them rather than to me. I believe that the organizational steps we have taken will make it possible to delegate authority more readily and improve the overall operation of the organization. In the coming months, we will be taking other organizational steps with these objectives in mind.

Mr. Chairmen, I would now like to proceed with an overview of NASA's FY 1983 program.

SPACE TRANSPORTATION SYSTEMS

For Space Transportation Systems the request of $3.468 billion for FY 1983 will move us out of Shuttle development flight test and evaluation and into the initial stages of operations. The past year marked significant gains toward providing the nation with an operational space transportation system. The key element of this system, the Space Shuttle, has completed two of its four planned orbital flight tests. Both flights, STS-1 and STS-2, were highly successful.

STS-1 accomplished all major flight objectives and demonstrated the viability of the total system. STS-2 fulfilled 90% of planned high priority flight objectives, demonstrated the reusability of the orbiter vehicle and its ability to support payload requirements. In both flights the astronauts reported the orbiter exhibited exceptionally good handling characteristics. The thermal protection system performed better than expected with anomalies well below that expected on first flights. Based on these results, we are approaching the next two orbital flight tests with confidence.

During the current fiscal year we will complete the last two orbital flight tests and accept delivery of the second orbiter vehicle, Challenger, now scheduled for this June. At the Kennedy Space Center prelaunch preparations are underway for STS-3 and the first line of Space Shuttle processing facilities and ground support equipment which supported the STS-1 and STS-2 launches are fully activated and a number of second line processing facilities are nearing completion.

SPACE SHUTTLE

The budget request for Space Shuttle in FY 1983 is $1.718 billion. By the coming fiscal year we will have completed basic development and flight test of the Shuttle, and therefore are not requesting funds for DDT&E. However, $72.5 million is requested for changes and systems upgrading to initiate modifications to improve reliability, increase operating efficiency and reduce costs. These funds allow for potential changes and systems modifications and unanticipated developments not included in the budget for production.

Our FY 1983 budget request for Space Shuttle production is $1,585.5 million for such activities as the orbiters, main engines, spares and equipment. Manufacturing of orbiters will continue on a schedule consistent with the needs of the Department of Defense and civil users.

For orbiter activities, we are requesting $933.5 million to cover such activities as OV-103 systems installations, factory checkout, and the thermal protection installation. OV-102 will be modified to full operational status and OV-104 fabrication and assembly will proceed with major subcontractor effort accounting for much of this activity.

$262 million is required to continue main engine fabrication and assembly of Full Power Level (FPL) flight engines. FPL certification testing will be supported leading to certification of the FPL engines in FY 1983 for ten missions. Life maintenance demonstration testing will be initiated at the completion of FPL certification testing.

For KSC production activities we are requesting $67 million for design, installation, checkout and validation of the second line processing facilities, including the solid rocket booster segment processing and storage facility, the second launch pad and the DOD secure firing room.

$323.0 million is being requested for the spares and equipment needed to provide rate tooling to support external tank and solid rocket booster production and the procurement of orbiter flight spares and crew equipment commensurate with the operational flight rate buildup.

We are also requesting $60 million for performance augmentation to enhance Shuttle ascent performance. Some erosion in payload capability and performance margins has occurred as a result of growth in the system's inert weight, particularly in the orbiter. The augmentation of ascent performance is needed to support certain national security missions and in particular, a scheduled launch from the Western Space and Missile Center in 1985. Alternate performance augmentation studies were previously planned to extend through FY 1982. However, due to early completion of the necessary trade-off analyses and the requirement to initiate development as soon as possible to meet the 1985 mission date, we have selected an approach

which will reduce the inert weight of the solid rocket boosters by using filament wound motor case segments to replace the heavier steel cases. A reprogramming request to initiate development is now pending with the Committee to apply study funds previously requested in FY 1982 to initiate development.

Also included in this request is funding to support a demonstration of the space transportation systems's ability to support a mission to retrieve an operating spacecraft and repair it on orbit or return it to Earth for refurbishment. It has been determined that the Solar Maximum spacecraft, which is now partially disabled, will serve as the target for this demonstration. This mission would restore this spacecraft to full operational status for further important data gathering.

SPACE FLIGHT OPERATIONS

In Space Flight Operations we are requesting a total of $1.707 billion. Significant accomplishments in the past year include delivery of the Spacelab flight unit, flight of the first scientific payload on STS-2, and; in addition to the two successful Shuttle launches, a perfect record of 11 successful launches using Atlas-Centaur, Scout, Delta and Atlas-F vehicles.

STS operations activities provide continuing support for the integration of the Space Shuttle system, the Spacelab, Upper Stages and all ground launch and mission control facilities into a versatile and economical overall system to accomplish user mission objectives.

Shuttle operations funding of $1.414 billion constitutes the largest portion of the overall Space Flight Operations budget. It supports a schedule of five planned launches in FY 1983; ten launches in FY 1984 and 13 launches in FY 1985. Activities include mission planning and flight operations, orbiter launch and landing processing, cargo processing and payload integration, and procurement of external tanks, solid rocket boosters and spare equipment. Also included is upper stages operations funding required for the production, delivery and operation of the Air Force Inertial Upper Stage (IUS) and the Solid Spinning Upper Stage (SSUS). Two IUS's during FY 1983 will carry two Tracking and Data Relay Satellites (TDRS) from low-Earth to geosynchronous orbit.

STS operations capability development funding of $85.4 million will be used to support upper stage development, Multi-Mission and Payload Support Equipment, Mission Control Center (MCC) upgrading, Payload and Operations Support and STS Operations Effectiveness. Multi-Mission and Payload Support Equipment will be developed into a standard, reusable inventory of equipment which can be used for a variety of payloads. Mission Control Center upgrading funding will be

used to reconfigure the MCC at the Johnson Space Center with new equipment and software to support the requirements of the STS operational flight schedule. FY 1983 funding for Payload and Operations Support will be used to support the development and activity of the Payload Operations Control Center at the Johnson Space Center to support NASA Spacelab missions in conjunction with the MCC.

Upper stage vehicles under development are the Inertial Upper Stage (IUS) and the Solid Spinning Upper Stage (SSUS). For FY 1983 we are requesting $32 million for continuing the necessary activities to modify the two-stage IUS for NASA missions.

We are requesting $82.4 million to support the engineering and technical support base, formerly called development, test and mission support. This redefined program activity provides minimal core capability to sustain an engineering and development base to support various Space Transportation Systems programs. This core capability provides basically for a five day, one shift operation of designated institutional research and development facilities. Demands in excess of this support are being funded by the benefitting programs.

FY 1983 funding for STS Operations Effectiveness will be used to provide for improvements in STS vehicle hardware, vehicle turnaround and cargo processing, mission operations and system software automation. This funding will also support management studies to develop strategies to insure maximum utilization of the STS while reducing the cost and complexity of STS operations and evaluating possible scenarios for future institutionalization of the system.

Most of the $113.2 million funding for Spacelab in FY 1983 will be used to continue the procurement of the second flight unit and spares and to support the first Spacelab mission in late FY 1983. This funding will also be used to continue work on the first Spacelab crew transfer tunnel and to complete the Spacelab simulator at JSC to support crew training for the first mission. In addition, funds will be required for the Spacelab integration contractor to support preparations for the first flight, software using the Software Development Facility at the Marshall Space Flight Center, and to continue integration and checkout of the flight unit hardware and software at KSC.

For advanced programs we are requesting $11.9 million. Major emphasis will be placed on continuing studies, engineering investigations and definition of mission options made possible by the Space Transportation System. Options include unmanned platforms in both low-Earth orbit and geosynchronous orbit, a permanently manned facility in low earth orbit and various support elements.

EXPENDABLE LAUNCH VEHICLES

Our request of $42.8 million for Expendable Launch Vehicles (ELVs) will be used primarily for the Delta launch vehicles to support NASA missions scheduled for launch in FY 1983 and subsequent years. These missions are the Infrared Astronomy Satellite and Landsat-D[1] launched from the Western Space and Missile Center and the Active Magnetospheric Particle Tracer Explorer launched from the Eastern Space and Missile Center.

Major funding for the ELV program continues to come from the reimbursable users of NASA ELV launch services: the DOD for navigation and communications satellites; NOAA for weather satellites and a variety of domestic and international commercial communications payloads.

SPACE SCIENCE AND APPLICATIONS

The budget request for Space Science and Applications totals $998.3 million in FY 1983. Although the request is constrained, most of the spacecraft development projects presently underway continue unchanged. The funds will continue, as planned, the development of the Landsat-D advanced remote sensing satellite for launch later this year. The Space Telescope development is also proceeding on plan for launch in 1985.

The Galileo Jupiter orbiter and probe mission will also be launched in 1985, as planned. However, the launch vehicle will now be the two-stage IUS instead of the Centaur. This change of launch vehicle will require adding a propulsion stage to the Galileo spacecraft and modifying the trajectory so that the spacecraft will pick up energy through an Earth flyby. The Jupiter arrival date will be delayed by approximately two years with some increase in mission operations costs. The restructured single spacecraft International Solar Polar Mission will also be launched on a two-stage IUS with an additional propulsion module. The launch date remains in 1986.

Development of the Earth Radiation Budget Experiment is also proceeding smoothly. We will be ready to launch in 1983, though the actual launch dates that NOAA can support are currently under review. We will be prepared to launch our part of the Search and Rescue mission this year. Development of the experiments selected for flight on the Upper Atmosphere Research Satellite will assure, if full development of this mission is approved and initiated, that these instruments will be ready.

The Gamma Ray Observatory will move into its hardware phase for both spacecraft and instruments. Development is still proceeding on a schedule leading to launch in 1988. The Venus Orbiting Imaging Radar mission will not be funded in FY 1982 or FY 1983, in effect cancelling the mission.

Our Shuttle Spacelab Payloads program is moving ahead well. Payload flights on the STS support virtually the entire scope of science and applications disciplines. The life sciences and materials processing programs rely on the low gravity environment of space to resolve basic physiological and physics questions. Remote earth sensing payloads, such as the Radar Imaging Systems flown on STS-2, utilize the near-Earth vantage point of the Shuttle orbit to gain valuable insights into the significance of surface features and the processes that have formed and continue to form our Earth. Physics and astronomy payloads use the Shuttle orbiter to look outward from the Earth to study the Sun and its effects on the Earth and to study phenomena occurring at the outermost reaches of the Universe. We are now planning to use Spacelab flights to make detailed observations of Halley's Comet during its apparition in 1986.

In the Explorer program, which recently launched two Science and applications research satellites, the Solar Mesosphere Explorer and the Dynamics Explorer, the development of the Infrared Astronomy Satellite and the Active Magnetospheric Particle Tracer Explorer will continue with the launch of the Infrared Astronomy Satellite now scheduled for later this year. We will soon initiate development of the Cosmic Background Explorer. This series of low cost missions has made and will continue to make major contributions to science and applications objectives, albeit at a somewhat slower pace than anticipated earlier.

Supporting activities included in the request run from major continuing applications projects to balloon, aircraft and sounding rocket flights to small university research efforts. The Geodynamics Program uses sophisticated ground-based, as well as space-based systems, to improve our understanding of the dynamic processes occurring at the Earth's surface. Research efforts at universities continue the analysis of data from past programs, carry out complementary laboratory and theoretical research, and help us develop new program concepts. The supporting programs also make a substantial contribution in advancing technology so that these future missions can be accomplished. Such technology development ranges from large scale activities such as those in Multi-spectral linear array technology to the small efforts in defining individual instrument concepts.

AERONAUTICAL RESEARCH AND TECHNOLOGY

A total of $232 million is requested for Aeronautical Research and Technology. The request will provide for technology advances in all aeronautical disciplines, stressing the technology areas judged to be the most critical. The FY 1983 budget preserves a strong research and technology base in aerodynamics, propulsion, materials and structures, aircraft controls and guidance, and human factors, and maintains the experimental facilities and people dedicated to aeronautics at the NASA research centers.

Advances in fundamental research and technology efforts will be supported in the FY 1983 budget. Nonintrusive experimental test techniques and the development of analytical and computational methods will help us better understand and predict aerodynamic characteristics associated with the flow of air over a variety of aircraft shapes in order to reduce drag and improve performance. Computational methods will be used to predict complex internal flow through rotating blade rows in turbomachinery and to model combustion processes in engines in order to control emissions and better understand the impact of alternative fuels on engine performance. Research will continue on metallic, ceramic, polymer, and composite materials necessary for high-temperature engine applications and lightweight airframe structures; and analytical methods will be used to improve life prediction and better understand and control the dynamic response of complex aircraft and engine structures. Other important advances are expected in electronics, aircraft control system software and architectural concepts and crew station technology necessary to model pilot behavior in a multivariable environment.

Included in the FY 1983 research and technology base are fundamental supersonic research, critical resources technology and advanced guidance and flight controls research. The discipline and vehicle-oriented research and technology base efforts in the various speed regimes will continue to pursue wind-tunnel investigations on advanced aircraft and rotorcraft concepts and technology for future military aircraft, and to examine the effects of promising technology advances individually and in combination.

We will also pursue systems technology efforts in the areas applicable to high-speed and low-speed aircraft. These efforts are directly interdependent with Department of Defense aeronautical research programs and will be the only focused Systems Technology activity within NASA. The high-speed activity will investigate advanced technology and new configuration approaches in cooperative wind-tunnel and flight research programs with the Air Force, Navy, and Defense Advanced Research Projects Agency (DARPA). Activity in FY 1983 will involve a variety of high-performance aircraft to investigate advanced concepts, including: the Advanced Fighter Technology Integration (AFTI) F-111 aircraft, the AFTI/F-16 aircraft and HiMAT Remotely Piloted Vehicle. The joint NASA/DARPA X-29A Forward Swept Wing flight demonstration program will undergo extensive wind-tunnel tests, computational analysis and ground tests in preparation for flight test in FY 1984.

The Low-Speed Systems Technology program will focus on joint NASA/Army rotorcraft technology activities. The rotorcraft effort will include research on new rotor configurations, using the NASA/Army Rotor Systems Research Aircraft, noise technology, full-scale rotor/fuselage interference tests and human factors research.

SPACE RESEARCH AND TECHNOLOGY

The FY 1983 Space Research and Technology request of $123 million will focus on maintaining a strong research and technology base in the disciplinary areas of aerothermodynamics, chemical propulsion, materials and structures, electronics and automation, and space power and electric propulsion. The funding requested will also continue activity in information, spacecraft, and transportation systems research and technology. These efforts are designed to study the interrelationships of discipline technology from an integrated systems point of view, and are critical to the successful transition of technology from the laboratory to useful application. In addition, systems-level studies conducted within the research and technology base will continue to focus the disciplines and system research and technology activities in directions which will lead to maximum benefits from available resources. Finally, systems technology programs involving the extension of ground-based research and technology activities to space using Shuttle, Spacelab, and free-flying vehicles will be continued. During FY 1983, a number of space technology experiments will be performed aboard the Shuttle/Spacelab.

As a first step in addressing the future potential for maintenance of permanent manned presence in space, we have initiated an identification of the critical technology requirements to enable design and development of such systems. A Space Station Technology Steering Committee (SSTSC) has been established consisting of representatives from Headquarters and each of the NASA Centers. This Committee is in the process of identifying the top technology challenges and organizing working groups to develop and recommend technology plans that would underlie future options for such initiatives.

ENERGY TECHNOLOGY

NASA's role in the development of advanced technology for terrestrial energy has come at the request of the agencies directly involved in Energy research and development and the Congress. We have funded some NASA energy work and supported the energy programs of the Department of Energy and other agencies. With continuing reductions in civil service manpower, these efforts detract somewhat from our ability to carry out our responsibilities for aerospace research. We have attempted to minimize this impact by choosing areas of activity which produce technology advances of potential benefit to aeronautics and space. However, as we look ahead, we find it will be necessary for NASA to phase out of support to energy programs by the end of FY 1983 in order to devote the available manpower to our traditional programs. We will structure our plans such that the investments that have been made will be protected and a smooth transition to new management is carried out where appropriate.

SPACE TRACKING AND DATA SYSTEMS

To meet the requirements of all NASA flight projects, a total of $508.9 million is requested to provide for continuation of vital tracking, command, telemetry and data acquisition support for Earth-orbital spacecraft, including all phases of the Space Shuttle flight program, as well as support for planetary missions, sounding rockets and research aircraft. Funds are also required for operations support for the mission control centers, computation and data processing facilities and communications. In addition, beginning in FY 1983, we have included the cost of the initial incremental lease payment for Tracking and Data Relay Satellite System (TDRSS) services.

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Our two networks, the Spaceflight Tracking and Data Network (STDN) and the Deep Space Network (DSN) provide worldwide support for both near-Earth orbiting satellites and deep space probes such as the encounter of the Voyager II spacecraft with Saturn in August 1981. These networks are preparing for a new era in data gathering capability with the advent of the TDRSS. Approximately 50 spacecraft, including the Space Shuttle and various planetary missions will be supported in FY 1983, along with intensive preparations for upcoming launches of approved programs such as Galileo, Space Telescope, Spacelab and TDRSS.

Some major activities to achieve economies during the past year include the closure of the ground STDN station in Quito, Ecuador, and the Tula Peak special purpose station in New Mexico, as well as a reduction in staffing at a number of tracking stations. Three 26-meter antennas of the Deep Space Network were also closed.

The TDRSS capability is planned to become fully operational in 1984. At that time, the TDRSS will support all low Earth-orbit spacecraft which will permit the closing of the majority of the worldwide STDN network. All other space missions, including planetary missions, such as the Voyager II encounter of Uranus in 1986, interplanetary spacecraft, and highly elliptical Earth-orbiting missions, will be serviced primarily from existing tracking station facilities in California, Spain, and Australia, which will be consolidated under the management of the Jet Propulsion Laboratory.

TECHNOLOGY UTILIZATION

For FY 1983, we are requesting $4 million for Technology Utilization to continue the transfer of NASA-developed technology to U.S. industry, the public and other government agencies. This represents a significant reduction from the current FY 1982 level of $8 million. While our primary focus will be on the continuation of active publication and technology dissemination activities, we will increase our efforts to acquire larger user contributions from both the private and public sectors. For example, we plan to continue phase zero feasibility and planning efforts in technology applications to define public sector applications projects in conjunction with other mission-oriented Federal agencies, with the view toward shifting budgetary responsibility for resultant projects to those user agencies. In addition, we will study the possibility of converting NASA Tech Briefs and other publications to paid subscription.

INTERNATIONAL COOPERATIVE ACTIVITIES

During this period of fiscal restraint, no nation can afford to pursue fully all scientific and technological opportunities. As a consequence, the many benefits that result from international cooperation such as access to foreign funds, foreign scientific and technological expertise, and foreign research and development facilities, become even more attractive. The 1980's will be a decade in which NASA will realize the benefits of many international activities begun in the 1970's, and will lay the groundwork for new and different forms of cooperation.

During the past year, several important milestones in some of our major cooperative projects were reached. For example, the Remote Manipulator System, which was developed, built and contributed by Canada, was successfully flown for the first time on STS-2. The European Space Agency recently delivered the first Spacelab flight unit to NASA; its maiden flight on the Shuttle is scheduled next year.

An increasing number of foreign nations are now well-equipped to participate fully in the exploration of space. Many have been actively involved for the past decade or more. Investments by foreign governments in space activities have steadily increased and we believe this trend will continue through the 1980s. This has the effect of generating competition in some areas, such as space launch vehicles, communications satellites and remote sensing systems. The United States must be prepared to meet this competition aggressively and we are taking a number of steps to help assure that U.S. space leadership is maintained. However, we need to keep in mind that these same increased capabilities and budgets can make foreign nations attractive as potential partners in future projects where it is in the U.S. interest to share costs or otherwise broaden support for its space activities.

CONSTRUCTION OF FACILITIES

The FY 1983 request for Construction of Facilities of $100 million has been limited to a constrained program that includes only minimum "hardcore" requirements in direct support of ongoing aeronautical and space programs and critical institutional base needs. Less than 15 percent of the request is for new construction, while the majority of the requirements are for modification, rehabilitation, or repair of existing facilities which will permit better utilization of the present physical plant and preclude some facilities becoming serious repair or replacement problems.

Approximately one-fourth of the funds requested are for the Space Shuttle and payload facilities work. The major requirements are for modifications of the manufacturing plant for the External Tank. These are required to provide a higher production rate capability than is presently available.

Major facility projects required for adequate support of aeronautical research and development comprise approximately $26 million of this request. These include modifications of two key wind tunnels at the Langley Research Center to improve testing precision and productivity.

The budget request also includes the continuing minor facilities work (minor construction, repair, and rehabilitation and modifications) that is critical to preserving the unique research and development capabilities of the NASA physical plant.

RESEARCH AND PROGRAM MANAGEMENT

The Research and Program Management request for FY 1983 is $1,178.9 million. About three-fourths of this account is required for civil service personnel salaries and related costs. About two percent is for travel which is vital to the management of our R&D programs. The balance is for facility support and related goods and services.

In 1981 two major institutional changes were implemented to improve the efficiency and effectiveness of operations. Last spring, Dryden Flight Research Center was made an integral part of the Ames Research Center, and the Wallops Flight Center part of the Goddard Space Flight Center. These actions were taken to focus the resources of each installation on what it can do best. The close relationship between Ames' and Dryden's efforts in aeronautical programs and Wallops' and Goddard's efforts in sounding rocket and airborne experiment programs provide an opportunity to improve overall program effectiveness through these consolidations.

Last fall an organizational change was made in Headquarters to assure the proper delegation of authority to all line managers, to set forth a clear distinction between line and staff, and to simplify and clarify Field Centers' reporting lines. The chief institutional change was to place centers under the managerial control of the Program Office from which they had already been receiving most of their programmatic directions. The Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center and the National Space Technology Laboratories report to the Associate Administrator for Space Transportation Systems; the Ames Research Center, the Langley Research Center and the Lewis Research Center to the Associate Administrator for Aeronautics and Space Technology; and the Goddard Space Flight Center to the Associate Administrator for Space Science and Applications.

In FY 1982, we are reducing our permanent civil service work force by 221 below the amended 1982 budget. This brings the civil service reduction from the original 1982 plan submitted a year ago to 1,061, a reduction of almost 5 percent. In 1983, we will reduce the permanent civil service work force by another 433, and NASA will be at its lowest civil service complement in over 20 years. We believe that we can achieve these reductions in a manner to minimize detrimental impacts, on NASA's programs and capabilities and on the individuals involved, while supporting fully our national commitments.

Requested increases, other than those for personnel and related costs, reflect only the amounts required to meet expected FY 1983 levels for support service contractor wage rates, utility rates and price levels for supplies, materials, equipment and other purchased services.

Even with significant civil service personnel reductions, NASA has been able to improve the ratio of minority and female professional employees in the Agency work force. In 1981, the ratio of minority professionals rose from 8.1 percent to 11.6 percent. Consequently, minority and female professionals now make up 20 percent of NASA's professional work force and 28.5 percent of the total work force.

CONCLUSION

In conclusion, this request represents a program which supports the major priorities of the Administration. It fully funds the Space Shuttle program and those aeronautics and space efforts related to national security while deferring or eliminating programs which could be performed by the private sector. In this context I believe it represents a balanced program which will provide the basis for future programs to exploit the full potential of the Space Transportation System.

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY THE CHAIRMEN DURING THE JOINT HEARING ON FEBRUARY 9, 1982, TO MR. BEGGS.

QUESTION A-1:

a. Does the NASA FY 1983 budget request fully support the objectives outlined in the Space Act of maintaining this Nation's leadership in aeronautical and space activities?

b. Does the budget request reflect a balanced space program in support of the objectives outlined in the Space Act?

ANSWER A-1:

a. We believe the budget request supports the objectives of the Space Act with respect to both aeronautics and space technology. Obviously, we could do more than we are proposing in this budget; but, I feel we have a sound program in aeronautics and space considering the Administration's fiscal objectives and the serious fiscal constraints which currently exist.

b. Yes, within the context of the national objectives and priorities enunciated by the President, the FY 1983 NASA budget request reflects a balanced space program. The program emphasizes bringing the Space Shuttle on line as an operational system to provide routine services for science, applications, technology and defense missions, as well as commercial and international launches. At the same time, the budget continues to support a vigorous program of activities in space science and applications and in space technology.

QUESTION A-2:

Could you list the new start candidates which NASA requested from OMB in order of priority? Please elaborate on the rationale for establishing the priority among these candidate new starts.

ANSWER A-2:

Priorities are developed for new starts through a series of judgments on the potential contribution, required training and technical readiness of each proposed initiative to the objectives of the National Aeronautics and Space program. Specific new start proposals need to be considered in relationship to other potential new initiatives and potential enhancements of currently approved programs. Key considerations in this process include:

- related activities in progress or proposed in the program areas involved,

- specific requirements and objectives for the proposed new initiative,

- the potential benefits of the new initiative,

- the estimated cost of the new initiative; and

- the technical readiness of the new initiatives and the confidence with which it can be undertaken.

In the final analysis, judgments have to be made and a priority list established. A list of the major new initiatives and activities included in the NASA recommendation to OMB in September in the priority order at that time is as follows:

1. 30/20 GHz Communications Satellite - long-term relief from geostationary orbit congestion and frequency allocation shortages requires the opening of this band (30/20 GHz) to commercial operations. This project will develop essential system performance, design, and operation data not obtainable through laboratory simulation or test, including on-orbit performance, systems performance under real load, and operational service evaluation.

2. Transport Aircraft Composite Structures - will generate technology permitting utilization of composites in primary structures to achieve the full potential of weight, fuel, and cost savings for transport aircraft through evaluation of composite design integrity; verification of design, analysis, and test procedures; and provision of a composites technology data base for structural qualification and certification.

3. Spacelab Payloads - will allow for significant capability enhancements by the development of instruments to augment the disciplines of space physics, astronomy, and geophysics.

4. Performance Augmentation Development - will develop and qualify a system capable of providing added Space Shuttle lift needed to perform specific national security missions.

5. Advanced Turboprop Phase III Acceleration - will develop the technology for efficient, reliable, and acceptable operation of advanced turboprop-powered aircraft at cruise speeds between Mach 0.7 and 0.8 with a cabin comfort level comparable to that in modern turbofan-powered aircraft while establishing a data base in installation aerodynamics and engine components unique to turboprop propulsion.

6. Fifth Orbiter Production - is needed due to the possibility that launch schedules in the late 1980's might be disrupted by the service loss of one of the four orbiters, or other factors such as extended orbital stay times.

However, priorities change over time and are adjusted during the budget process to recognize the overall priorities of the Administration, such as the need for stringent fiscal restraint and increased emphasis on Defense. In this context, the 1983 Budget now includes the important Performance Augmentation Development (SRB lightweight cases), but does not include the other initiatives listed above.

QUESTION A-3:

a. Since the authorization hearings last year, has there been any change in the schedule commitments for delivery of the Production Orbiters?

b. What are the delivery schedules envisioned by the budget request?

c. Do the currently envisioned production orbiter delivery schedules satisfy Department of Defense requirements?

d. Has NASA requested funds for the fifth orbiter in the 1983 budget?

e. What funding level and management decisions would be required to maintain the most efficient production schedule?

ANSWER A-3:

a. There has been no change. However, within the available funding for FY 1982, the highest priority has been assigned to maintaining the delivery schedule for Orbiter 099 and Orbiter 103. This may cause some Orbiter 104 activities, scheduled for FY 1982, to be rephased. This could have a potential impact on the Orbiter 104 delivery schedule.

b. The following is the current orbiter delivery schedule:

Orbiter 099	June 1982
Orbiter 103	September 1983
Orbiter 104	December 1984

c. Yes, the current orbiter delivery schedules satisfy both the DoD Vanderberg Air Force Base (VAFB) facility operational requirements and DoD mission requirements. Current plans provide for transferring Orbiter 103 in early 1985 from the Kennedy Space Center (KSC) to VAFB to support the VAFB operational date of October 1985. NASA mission model projections are also consistent with this OV-103 transfer. Prior to the activation of VAFB, DoD missions will be flown on vehicles OV-102 and OV-099 from KSC.

d. The FY 1983 Congressional budget does not identify funds for procurement of a fifth orbiter.

e. The current delivery schedule for OV-099, OV-103, and OV-104 must be considered the most reasonable and efficient production schedule given the current in-house and subcontractor hardware delivery schedules.

In terms of the procurement of additional orbiters, there is little disagreement that combined, multiple buys are more cost-effective. The delivery of orbiters approximately 12 months apart is stated by the Rockwell Corporation to provide the most-effective utilization of in-house facilities and subcontractors.

QUESTION A-4:

a. Could you elaborate on the most recent report of the Aerospace Safety Advisory Panel related to the Space Shuttle?

b. Are you aware of any unresolved safety issue concerning the Space Shuttle?

c. Do the results of the report hold true for subsequent Space Shuttle flights as well?

ANSWER A-4:

a. The Panel presented their annual report and discussed their assessments, conclusions, recommendations and future activities with NASA on January 21, 1982 To assure that we obtain their counsel on a timely basis, we maintain a continuing dialogue with them. The report provided, among other things: (1) five findings, (2) nine recommended actions, and (3) areas of concentration during 1982. See Chart A for details. Dr. Stanley Weiss and Gen. James Abrahamson, Associate Administrators for Space Transportation Operations and Systems, respectively, have also met with the Panel and discussed the report and their response to it. In most cases, the Panel's concerns and recommendations are similar to our own thinking. For example, the Panel noted that NASA incidents and accidents demonstrate poor local supervision of specific procedures and a vague line of authority for essential tasks. We have been greatly concerned as well and a number of efforts are underway at various NASA and contractor locations to improve our safety performance, including safety workshops, examination of current safety policies and their implementation, and special programs by each of the Associate Administrators and a personal commitment to safety by each center director. As you know, the Agency is committed to a rapid Shuttle turnaround; the achievement of which will necessitate some risks. It is my desire that the Panel stay abreast of those risks to determine whether or not they remain reasonable. This is also in line with a Panel recommendation. As part of this activity, the Panel will participate in programs reviews leading up to launch.

b. With the successful completion of the first two Shuttle missions and our continuing aggressive and systematic safety program, we are not aware of any unresolved safety issues. I have asked the Panel to review the structural adequacy of the Shuttle system and the safety implications associated with the use of lightweight External Tanks and lightweight solid rocket motor cases. There are the same residual risks since there is always a degree of risk associated with using such things as solid rockets and the single layer thermal protection system on the orbiter. Each residual risk has been subjected to indepth scrutiny to make sure that the effects and likelihood of occurrence have been minimized.

c. The Panel's report addresses current and future Shuttle activities with emphasis ongoing from the DDT&E period to the fully operational period. Therefore, the assessments, conclusions, and recommendations do relate to subsequent Space Shuttle flights. For example, the Panel's discussion of streamlining turnaround procedures and expanding the performance envelope along with redline assessments are continuing activities now and in the future.

QUESTION A-5:

Because of cost and schedule problems which had occurred in a number of Agency programs, in September 1980 the Subcommittee on Space Science and Applications requested that the NASA Administrator appoint a team of senior officials to review project management procedures and procurement regulations for updating, if necessary. Do you agree with the conclusion and recommendations of this study? Could you summarize NASA's actions in implementing the recommendations?

ANSWER A-5:

I agree with the conclusions and recommendations of this study. On January 6, 1982, I issued a policy statement directing that the findings of this study be implemented for all future projects. To quote from this policy statement: "When this Agency goes forward within the Executive Branch or to the Congress and the public, I want its word to be reliable, its reputation honorable, and its performance unassailable."

The procedures that will be used to implement this policy have been documented in a NASA Handbook and distributed to all NASA program offices. Some of the major elements in this handbook are: a high degree of project definition before a program is presented as a new start; a formal definition and cost review to be conducted by a non-advocate team; commitment in writing by the center director and the project manager as to the resources required for project completion; the establishment of a contingency fund for each project, the magnitude of which will be a function of the assessed development risk; and an additional fund to be held at NASA Headquarters to protect against scope changes affecting the runout costs.

All new initiatives that will be presented to the Executive Branch and the Congress will be in adherence to this policy and I, therefore, expect a significant reduction of the cost and schedule problems that have occurred in the past.

QUESTION A-6:

One generic problem identified by this review team was that proposals should be evaluated and contracts awarded based on technical and management factors rather than cost thereby leading to more realistic cost estimates by contractors. Does NASA have the legal authority to implement this recommendation? Could you comment on the validity of this recommendation?

ANSWER A-6:

The thrust of the recommendation made by the study team is that more emphasis be placed on technical, management, and past performance evaluations in the selection of R&D contractors rather than placing reliance on low cost as the determining selection discriminator. The team concluded that false economies have resulted from contractor selections where the promise of low cost performance failed to materialize. At the same time, the team recognized that cost of performance, both as proposed and as adjusted by NASA for probable cost estimating, remains a material evaluation factor for selection purposes. Applicable procurement law (10 U.S.C. 2304(g)) requires that proposals, including price, be solicited from the maximum number of qualified sources consistent with the nature and requirements of the supplies or services to be procured. The clear implication of this and related statutory provisions is that price is always a factor for evaluation by the Government. NASA regulations clearly comply with these legal requirements. For example, the NASA Source Evaluation Board Manual, which governs NASA evaluations of major procurements by Source Evaluation Boards, requires that four evaluation factors be addressed: Mission suitability (which include technical and management considerations); cost (both proposed and

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

	Budget Plan		
RESEARCH AND DEVELOPMENT	FY 1981	FY 1982	FY 1983
Space Transportation Systems	2,728,600	3,090,100	3,467,800
Space Shuttle	1,995,000	2,163,000	1,718,000
Space flight operations	679,200	895,900	1,707,000
Expendable launch vehicles	54,400	31,200	42,800
Space Science	541,488	568,000	682,000
Physics and astronomy	323,700	323,500	471,700
Planetary exploration	175,600	205,000	154,600
Life sciences	42,188	39,500	55,700
Space and Terrestrial Applications	340,350	333,800	320,300
Space applications	331,550	325,800	316,300
Technology utilization	8,800	8,000	4,000
Aeronautics and Space Technology	384,000	344,000	355,000
Aeronautical research and technology	271,400	233,000	232,000
Space research and technology	110,700	111,000	123,000
Energy	1,900	---	---
Tracking and Data Acquisition	339,900[a/]	402,100[a/]	508,900
TOTAL RESEARCH AND DEVELOPMENT	4,334,338	4,738,000	5,334,000
CONSTRUCTION OF FACILITIES	116,950[a/]	98,700[a/]	100,000
RESEARCH AND PROGRAM MANAGEMENT	1,071,064	1,144,700[b/]	1,178,900
TOTAL	5,522,352	5,981,400	6,612,900
OUTLAYS	5,421,300	5,826,500	6,576,100

a/ Reflects reprogramming of R&D funds to CoF: 1981 program $1.2M, 1982 program $2.9M.
b/ Includes increased pay costs of $41.4M.

probable); experience and past performance, and, other factors. It is the responsibility of the NASA source selection official designated for a particular procurement to judge which proposal is the most advantageous to the Government, all factors considered. In any given procurement, the selection decision may involve a series of trade-offs involving technical capability and cost as well as other aspects of the evaluation. There is a great deal of discretion involved in the decision process which is permissible as a matter of law. The study team has recommended that more attention be paid to the development of evaluation criteria which will provide more meaningful mission suitability and past performance discriminators which can be utilized by source selection officials in making trade-off decisions involving the other evaluation factors. The legal procurement framework already exists to allow selection officials to place greater weight on technical, management, and past performance factors than on cost in appropriate cases. In any event, however, reasonable cost of performance, to the extent it can be identified in the evaluation process, will continue to be a material factor in NASA proposal evaluations and contractor selections.

The recommendation is valid when considered within the overall context of NASA's procurement process as explained above.

QUESTION A-7:

Could you elaborate on the status of NASA's plans for a Shuttle upper stage? If NASA pursues the short wide-body Centaur will you conduct a competitive procurement? What would be the justification of a sole-source procurement?

ANSWER A-7:

Current NASA plans are to launch Galileo and ISPM on the two-stage IUS with the addition of a third stage kick motor to be provided by the Galileo and ISPM spacecraft program. The IUS program is proceeding on that basis.

NASA does not, at this time, have any requirements for a short wide-body Centaur. If NASA were directed to develop a short wide-body Centaur, we would not conduct a competitive procurement.

The short wide-body Centaur is a modified version of the current Centaur being flown on the Atlas-Centaur expendable launch vehicle. General Dynamics is the only company building, or who has built, Centaur vehicles. Therefore, the contract for the short wide-body Centaur would be procured from General Dynamics on a noncompetitive basis.

QUESTION A-8:

What is the cost impact on the Galileo and ISPM programs of the short wide-body Centaur as compared with the IUS?

ANSWER A-8:

In performance, the short wide-bodied Centaur has double the capability of the two-stage IUS to geosynchronous orbit (10,000 lbs vs 5,000 lbs). However, for the Galileo mission the short Centaur requires an

earth gravity assist trajectory, just as the two-stage IUS does, which results in equivalent trip time and increases the Galileo mission costs to about the same as the IUS. The cost comparison results in an advantage of approximately $250 million to the IUS option. This advantage is based on a comparison of the total cost of the Centaur versus the costs required to modify the IUS for planetary missions. The short wide-bodied Centaur will, increase the science return at Jupiter by allowing eleven satellite encounters as compared to six encounters with the IUS, however, approximately 85-90 percent of the original science objectives can be accomplished by the IUS launch mode.

There would be essentially no change to the International Solar Polar Mission or its cost if the short wide-bodied Centaur were used as a launch mode versus the IUS.

QUESTION A-9:

a. Could you elaborate on the respective roles of NASA and the Space Telescope Science Institute in managing and operating the Space Telescope?

b. How much money is in the budget for Space Telescope Science Institute? When will the Space Telescope be launched?

ANSWER A-9:

a. NASA maintains overall responsibility for management of the development and operation of the Space Telescope (ST). In-orbit operations will require three key elements: (1) The orbiting telescope; (2) a ground facility; and (3) the Tracking and Data Relay Satellite System (TDRSS) to link the two together.

The ground facility will consist of three major parts: The ST Operations Control Center and the ST Data Capture Facility, both located at the Goddard Space Flight Center, and the ST Science Institute, located on the Homewood Campus of Johns Hopkins University. NASA has awarded a contract to the Association of Universities for Research in Astronomy (AURA) to provide and operate the ST Science Institute.

Operating under the terms of the contract with NASA, and in its role as operator of the Science Institute, AURA will select observers and researchers, support the selected observers, develop the observing schedule, provide an ongoing evaluation of the scientific performance of the ST and its scientific performance of the ST and its scientific instruments, as well as process, archive, and publicize the scientific data obtained by the Space Telescope.

In summary, the selected Space Telescope Science Institute contractor, AURA, will play a vital role in the science-related operations of Space Telescope, and that role will be implemented under the terms of a Government contract, managed by NASA.

b. Approximately $7 million is included in the FY 1983 budget request for the continued development of the Science Institute. This funding is included in the Physics and Astronomy Mission Operations and Data Analysis request. The scheduled launch date for the Space

Telescope is the first half of 1985.

QUESTION A-10:

Could you elaborate on the status of NASA plans for maintaining the Delta and Atlas-Centaur production lines? What efforts are underway to reduce the Delta and Atlas-Centaur costs to assure a competitive posture with regard to Ariane?

ANSWER A-10:

The Delta and Atlas-Centaur production lines are being maintained primarily with reimbursable user funds and will continue this way as long as users require the use of a Delta or an Atlas-Centaur vehicle. Specifically, the Atlas-Centaur production line is totally maintained by reimbursable customer funds (Intelsat and the U.S. Navy (FLEET-SATCOM) since NASA has no current planned use for this vehicle. The Delta, however, is still being used for NASA missions (Landsat-D, -D1, and AMPTE) and will require appropriated funds in FY 1983 and subsequent years. However, the NASA mission funding represents a minor piece of the Delta production and launch requirement.

Every effort possible to reduce costs for Delta and Atlas-Centaur and to assure a competitive position with regard to Ariane is being explored. However, since Delta and Atlas-Centaur systems are being maintained on a reimbursable basis, they are procured for approved missions only; thus, particularly with Atlas-Centaur we cannot maintain a steady production line independent of launch requirements. The result for Atlas-Centaur is procurement of small lots of hardware which is inefficient and expensive.

To date, the efforts to reduce costs for Delta and Atlas-Centaur consist of a review of the overall production and launch sequence workload to eliminate or make more efficient the procedures being followed. We have slowed down production and revised launch schedules as much as demand permitted to level launch crew requirements. Other efforts consist of averaging improvement costs to spread them over a larger production base. In addition, a closer look at the method of allocating NASA's overhead and services to reimbursable customers is being investigated.

QUESTION A-11:

a. How would you characterize the workload at the various centers?

b. Are the various centers capable of taking on new projects? Or are they overstaffed given that we have no new projects?

ANSWER A-11:

a. The workload at Ames Research Center (ARC), Langley Research Center (LaRC), and Lewis Research Center (LeRC) involved in aeronautics and space technology is very high. Much of the work is of a basic, fundamental nature, performed in-house by a staff of talented, dedicated, civil service employees who represent a unique national research capability. The in-house research efforts are complemented by contracted research, and a small amount of contracted project activity. As the budgets for contracted research and contracted

project activity have declined, we have tried to keep most of the critical research efforts going with the in-house program.

The workload at Johnson Space Center (JSC), Marshall Space Flight Center (MSFC), Kennedy Space Center (KSC), and the National Space Technology Laboratories (NSTL) involved in our Nation's Space Transportation System is very high. We are entering a period when the flight rate is increasing, DDT&E is coming to an end but some changes and improvements will continue to be made, production is building up, and we are planning and implementing the transition to the STS operations era, which has been accompanied by some civil service work force reduction.

Goddard Space Flight Center and Jet Propulsion Laboratory are currently adequately staffed to support their assigned responsibilities.

b. No NASA center is overstaffed. Furthermore, there are far more promising ideas and tasks to pursue than there are staff and funds.

It is important to recognize that in the R&D business some new work in the form of studies, advanced development, research and technology, and even project definition, must be undertaken by every center each year. Such work is necessary if a center is to retain its technical edge and assure that NASA has access to an adequate and proper technical and economic decision base. This type of work is pursued primarily in-house and provides an in-house base and capability for initiating new work and projects.

With regard to being able to take on more projects, the answer is definitely "yes". While we cannot do much with our current in-house research due to staffing limitations, we could support and effectively manage more contracted projects and research activity. There are many areas to be explored and advances to be made in aeronautics and space technology; therefore, our challenge is to decide which are the most important and the most promising opportunities.

QUESTION A-12:

What are your plans with regard to NASA's future role in energy R&D reimbursable activities?

ANSWER A-12:

As currently planned, NASA will phaseout support of terrestrial energy research and technology development at the LeRC by the end of FY 1983 to devote the available manpower to NASA's traditional program. JPL will continue to provide support to energy areas where they have the capabilities required to successfully accomplish program goals.

QUESTION A-13:

Are you familiar with the Global 2000 report which predicted dire resource problems by the year 2000? (Increased population versus less (per capita) food, energy, water, minerals, etc.) It seems that the conclusion one must draw from the report is that we have to do a better job of managing our resources. To manage you need information.

Is NASA applying its remote sensing expertise to this problem in a comprehensive approach. Are we cooperating with other countries that will have much worse problems than the United States?

ANSWER A-13:

NASA is continuing to develop techniques for gathering information through remote sensing which may be applied to improving the management of the world's renewable and nonrenewable resources which will allow man to monitor and predict agriculture production, land use, water supply and demand, pollution and weather and to assist in the exploration for mineral and petroleum resources. A number of countries including Canada, Argentina, Brazil, India, and Japan have their own satellite ground stations. In addition, the Peoples Republic of China is planning to construct a satellite ground station. The ground stations will allow these countries to acquire satellite data directly as well as share in the analysis of the information.

QUESTION A-14:

Is NASA fully committed to continuing the development of remote sensing technology for civil applications? How committed are you?

ANSWER A-14:

NASA continues a broad-based and strong research and technology effort in remote sensing to define an advanced multispectral solid state sensor for a civil remote sensing satellite system. This sensor will incorporate capabilities and a such as high spatial and spectral resolution, photogrammetry, and onboard data compression.

Major technology efforts have recently been initiated including the development of short-wave infrared detectors and focal planes, multispectral charge-coupled device modules, and advanced passive cooler designs. In the near term, NASA will continue to develop, test, and validate key technology elements and define space-borne experimental missions for research utilizing the Shuttle as the observing platform.

The research and technology development efforts, which are multi-year development contracts reflect the appropriate NASA role in supporting the development of remote sensing technology.

QUESTION A -15:

Other nations, notably France and Japan, have recognized the economic importance of satellite earth remote sensing and are developing their own satellite systems. Is the United States doing everything it can to ensure that the United States, who pioneered satellite remote sensing, continues to develop the applications for this important data?

ANSWER A-15:

NASA is well aware of the increasing competition and aggressive new initiatives from foreign nations in the area of satellite remote sensing. The NASA R&D program will permit sensor capabilities

exceeding greatly those of the sensor system under development in Europe and Japan. This NASA technology development, called the multi-linear array (MLA) program, includes development of short-wave infrared focal planes, multispectral charge-coupled devices, and a novel imaging spectrometer concept.

The Shuttle will be used as the spaceborne observation and test platform for the critical technology elements with plans for the possible development of an experimental instrument. We also expect to continue, in parallel, observational research by developing advanced scanners to generate interim high resolution multispectral data for use by the remote sensing community.

QUESTION A-16:

What preparation is NASA making for the 1982 United Nations Conference on Peaceful Uses of Outer Space (UNISPACE 82)?

ANSWER A-16:

U.S. Government preparations for UNISPACE 82 are under the direction of the Department of State which will set up a Coordinator's Office in the near future. Until this office is established, however, NASA in close coordination with the State Department is chairing an interagency working group preparing for UNISPACE 82. The interagency group is reviewing on an expedited basis the U.S. national paper for UNISPACE 82 and the draft conference report for UNISPACE. Preliminary consideration of possible U.S. initiatives or UNISPACE and the composition of the U.S. delegation has also begun.

In addition, NASA is making arrangements with the American Institute for Aeronautics and Astronautics for their services in coordinating the U.S. industrial exhibition for UNISPACE. NASA is planning to participate in the U.S. Government exhibition which will be integrated into the industrial exhibition.

Although NASA will continue to play a key role throughout preparations for the conference, it is expected that most of the day-to-day preparatory activities will be assumed by the Department of State Coordinator's Office once it begins functioning.

QUESTION A-17:

What should the United States do at this important conference of nations to promote U.S. accomplishments in space for human benefit and to educate less developed nations as to the benefits from space technology particularly satellite remote sensing?

ANSWER A-17:

There are already significant U.S. efforts underway in response to the desire of developing countries to increase their involvement in space activities, a desire which will find an important focal point in UNISPACE 82. It is expected that the United States will emphasize these efforts at UNISPACE. In the area of remote sensing, developing countries continue to express interest in acquiring ground stations for reception of Landsat data; new stations in India, Argentina, and Thailand have either begun operation recently or are under develop-

ment. The United States is participating in discussions among current and prospective remote sensing system operators on complementarity and compatibility of data. This "operators group" is also sponsoring regional meetings to survey the data needs of potential developing country users, to take these into consideration when designing their remote sensing systems. The Agency for International Development's activities, in providing assistance in applying remote sensing to development, have resulted in a number of successful applications projects and the establishment of regional and national remote sensing centers in Africa and Asia. More specialized assistance and training in remote sensing applications is provided by the U.S. Geological Survey and the Department of Agriculture. The AID Rural Satellite Program, which will use pilot projects to demonstrate the use of communications satellites to provide telecommunications to remote areas in developing countries, is also underway with initial pilot projects to take place in Indonesia, Peru, and Senegal. Lastly, the various U.S. Government technical experts will continue, as Agency resources permit, to participate in UN-sponsored seminars, symposia, and workshops which deal with applications of remote sensing and space communications in social and economic development.

The United States is also planning an exhibition for UNISPACE. A major preliminary exhibition plan is to seek heavy private sector participation so that U.S. leadership in making aerospace technology available can be displayed. In addition, the Government portion of the U.S. exhibition will emphasize the significance of the space transportation system and focus on those U.S. programs of particular interest to the developing countries, including remote sensing, communications, terrestrial applications of photovoltaics and "spin-offs" from the U.S. space program.

The U.S. national paper is being written primarily for a developing country audience and will discuss current and future aspects of the U.S. civil space program of particular interest to the developing countries. The paper includes sections on applications to development of remote sensing, satellite communications and other space technologies.

As planning progresses, Congress will be kept informed as to NASA's role in the formulation of possible U.S. strategies and initiatives for this important international conference.

QUESTION A-18:

The budget request includes no new initiatives. What concerns do you have with regard to maintaining national capabilities and disciplinary skills?

ANSWER A-18:

Maintaining national R&D capabilities and skills is more critical today than ever before. This Nation is facing increasingly effective competition from abroad across the entire spectrum of high technology endeavors, ranging from aeronautics, electronics, avionics, computers, launch vehicles, and spacecraft. We no longer enjoy a monopoly of expertise or technical skills in any of these areas.

A major objective of NASA is to not only preserve national R&D

capabilities but to enhance them. Clearly the activities carried out on behalf of the STS program do contribute to the maintenance and development of such capabilities. NASA, however, has a balanced R&D program which extends far beyond the STS. We are accelerating our advanced mission and systems planning activities in order to be ready to support any future mission initiatives. We are continuing a well-founded advanced research and technology program and we have an active and world-recognized (and envied) program in space science and exploration.

Much has been said lately regarding the state of engineering manpower and training in this country. I, too, am concerned about these matters and NASA is actively participating with the National Science Foundation (NSF) and other agencies in a major study on education and utilization of engineers. Our concerns stem from our need to attract and retain the in-house competence we need to effectively and efficiently manage our programs, the ability of industry and universities to continue to work with us as closely and effectively as in the past, and the availability of engineering manpower to work on our programs. These matters merit and will receive close attention on our part.

QUESTION A-19:

In your opinion, what is the single biggest most exciting question in space science today, the question whose answer is most likely to change models or theories? What is NASA doing about this question?

ANSWER A-19:

One of the central challenges of contemporary science is to try to determine the nature, origin, and evolution of the universe. In addressing this great cosmological question, a number of subquestions must be considered, each of which illuminates the central question from a different direction: (1) How is matter distributed in the universe? (2) What is the overall scale of the universe? (3) Will the universe continue to expand or will it ultimately recondense and then reexpand? (4) How do galaxies form? (5) What changes take place in galaxies during their lifetime? (6) How do stars form? (7) How do stars evolve in time? (8) Do we completely understand the laws of physics, which govern the behavior of matter? (9) How do planets form and evolve? (10) Was the creation of life a singular event, or is it commonly spread throughout the universe, originating as the natural consequence of a series of processes which take place everywhere?

Virtually all aspects of the Space Science and Applications programs are directed toward obtaining answers to this series of questions. Our orbiting observatories have played a central role in the evolution of the concepts of the universe which have taken place in the past 25 years. Discoveries of celestrial x-ray and gamma-ray sources have revealed the existence of entirely new types of objects and have shown that we live in a universe characterized by the routine occurrence of vast, explosive events of unimaginable violence. Our probes to the planets have provided new insight into the diversity of objects existing within the solar system and permitted significant steps forward in understanding how the planets were formed and developed. We have just begun to understand the true complexity of the interaction between the sun and the planets through the solar

wind.

Projects now under development will enormously extend our knowledge of how objects within the universe were formed and evolved. For example, the Space Telescope will be used to study the overall structure and dynamics of the universe, it will have the capacity to study the physics of galaxies in considerable detail; the Gamma Ray Observatory will provide new insight into the nuclear and elementary particle processes taking place in the universe and will examine such questions as how the chemical elements are synthesized in stars; the Infrared Astronomy Satellite will survey the regions where stars are being born and tell us about the nature of the cold clouds of gas and dust which are "stellar nurseries"; the Cosmic Background Explorer will map the echos of the explosions thought to have marked the beginning of the universe and help us decide whether the primeval explosion was turbulent or uniform, whether it occurred simultaneously everywhere and how the first galaxies were formed. The International Solar Polar Mission (ISPM) will give us the first three-dimensional picture of how material emitted under the sun flows through the solar system. Basic new understanding of the physics, chemistry, and meteorology of planetary atmospheres will be returned from the Galileo mission to Jupiter as well as from Voyager observations of Uranus. The Voyager spacecraft will also continue to search for the boundary between the region of space dominated by the solar wind through interstellar space.

It is obvious that we have made enormous progress in our understanding of the nature of galaxies, stars, and the solar system during the brief 24 years of the space age. Therefore, the program I have outlined will continue the search for the answers to these questions for many years in the future.

QUESTION A-20:

What are NASA's future plans for planetary exploration activities? What is the impact of cancellation of the Venus Orbiting Imaging Radar (VOIR) mission on these plans?

ANSWER A-20:

The near-term future of the planetary program is one which gives highest priority to the operation of the Voyager spacecraft and to the development of the Galileo mission to Jupiter. Research in the planetary sciences will continue analysis of data from past missions. NASA's long-term planetary mission strategy will concentrate on defining lower cost explorer class of deep-space missions to continue the exploration of solar system bodies as yet little known and to deepen our understanding of those planets that have already been studied in some detail.

The decision not to initiate development of the VOIR project was made in recognition of the pressing need for fiscal restraint and NASA priorities for space science. However, we are now examining new concepts whereby a portion of the VOIR science goals could be achieved through a less sophisticated and costly means. These concepts will be thoroughly studied by JPL, the science community, and the radar and spacecraft contractors. If a sufficient mission concept can be identified, this mission will be considered in the preparation of

future budget.

QUESTION A-21:

What are NASA's future plans with regard to the Jet Propulsion Laboratory? What is the impact of the VOIR cancellation on the Jet Propulsion Laboratory? Are there any ongoing discussions regarding the transfer of JPL from NASA to the Department of Defense?

ANSWER A-21:

NASA plans to continue Research and Analysis efforts, Mission Operations and Data Analysis activities, and Galileo Development at the Jet Propulsion Laboratory (JPL). In addition, operations of the Deep Space Network (DSN) and experiment development and support to such projects as the Space Telescope and International Solar Polar Mission will be continued. JPL is also responsible for the Infrared Astronomical Satellite launch in late 1982 and its subsequent operations. If NASA proposes, in a future budget, a less sophisticated VOIR concept, JPL will be made responsible for its future development. In addition, NASA will continue to study other potential future mission concepts which may also be assigned to JPL.

The VOIR development was to have been initiated at the beginning of FY 1982 under the management of the Jet Propulsion Laboratory. The actual development of the spacecraft and synthetic aperture radar, however, would have been done by contractors. The people who would have worked on the VOIR project will be transferred to other NASA projects at JPL or will be involved in defining new projects such as a less sophisticated VOIR project. JPL is also soliciting outside work to augment the ongoing NASA activity.

QUESTION A-22:

What is your view toward cooperative international space programs?

ANSWER A-22:

In the past two decades, NASA has successfully carried out its mandate in the 1958 National Aeronautics and Space Act to cooperate with other countries in conducting our programs. NASA has had over 1,000 agreements with over 100 countries that cover the full range of cooperative relationships. The benefits from such cooperation are numerous. Cooperative partners share the cost of projects, meaning that NASA benefits from receiving free mission-related equipment and support that we might otherwise have to fund ourselves. Other benefits include access to foreign scientific and technological expertise and foreign facilities.

During this period of fiscal restraint, no nation can afford to pursue fully all scientific and technological programs. Therefore, the numerous benefits that result from international cooperation become even more attractive. NASA will continue to pursue opportunities for new cooperative activities, building on its long successful history of cooperative relationships.

QUESTION A-23:

The U.S. world-wide lead in new technology is being seriously challenged. International competition for sales of space and ground support hardware is growing (or already lost). What can NASA do? What is it doing?

ANSWER A-23:

NASA's primary role in helping U.S. industry to meet this international competition is through maintaining a vigorous U.S. research and development program. Even though certain foreign technologies still lag that are available in the United States, we must continue strong research and development funding in order to maintain this lead. The FY 1983 NASA budget request contains activities in research and technology funding designed to maintain U.S. technological superiority in such areas as the space launch vehicles, space science and other advanced program developments. In the area of launch services, NASA is aggressively pursuing improvement programs to lower production and operating costs to ensure that we are competitive with foreign systems like Ariane.

It is clear, however, that NASA cannot solve this problem alone. NASA's efforts must be complemented by private sector application of the fruits of Federal and private R&D efforts and by aggressive marketing of the resulting products and services. What additional role the Federal Government should play, if any, in such areas as assurance that U.S. firms are not victims of unfair competitive practices, is currently being studied by the Administration.

QUESTION A-24:

In the legislative report accompanying the FY 1982 authorization legislation, the Committee requested that NASA reassess the implications and significance of the National Oceanic Satellite System (NOSS) concept. What is the status of this reassessment? When does NASA plan to submit this reassessment to the Committee?

ANSWER A-24:

NASA has prepared a draft reassessment statement on the implications and significance of the NOSS concept. The statement will be forwarded to the Congress as soon as it has been appropriately staffed.

QUESTION A-25:

In the FY 1982 authorization report, the Committee noted that termination of the space applications Technology Transfer activities would represent a breach of NASA's charter which requires the widest practical dissemination of research and development results. Yet, you include no funds in your 1983 request for this activity. How do you explain this disregard of Congressional direction and intent?

ANSWER A-25:

Although Technology Transfer as a distinct program element is not identified in the FY 1983 budget request, Technology Transfer will be continued as part of the Space Science and Applications. The

Regional Remote Sensing Applications Program, which was a part of the Technology Transfer program, is now assigned to the Earth and Planetary Exploration Division as a result of the recent NASA reorganization.

In addition, FY 1983 is a transitional year in which our emphasis will move from applications of Landsat multispectral (MSS) data to the technique development and testing of new improved Landsat-D Thematic Mapper (TM) data. As a result, we no longer plan to conduct broad based MSS technology demonstration projects through our Technology Transfer Program. Instead, we plan to place more emphasis on the conduct of experimental test and evaluation of emerging new remote sensing techniques through cooperative projects with user organizations. We will also continue to use universities as a mechanism to develop, test, and evaluate new remote sensing techniques with users. We believe that these two activities will make better use of the available resources and continue to involve the user community in improved space applications technologies.

In keeping with the need for fiscal restraint we had to balance the Technology Transfer activities against NASA's overall charter in space research and development. Therefore, the Technology Transfer activities were reduced to the basic function of test and evaluation of emerging new techniques. We do not believe, however, that this will jeopardize the overall progress made in transferring Landsat capability to the user community. The Technology Transfer Program has made significant progress since its initiation in 1976, and as a result, has successfully developed a critical mass of active state users who are beginning to show some independence in their use of Landsat MSS data.

QUESTION A-26:

What are NASA's long range plans for the Technology Utilization program? NASA's FY 1983 budget request would appear to indicate plans to phaseout this program: Is this correct?

ANSWER A-26:

NASA's long range plans for Technology Utilization (TU) are:

a. To develop a more economical method of transferring technology from our R&D base to both the private and public sectors;

b. To develop ways to reduce the time it takes to identify target opportunities and transfer technologies that will benefit national productivity; and

c. To explore ways to have the users pay for a greater portion of the technology transfer process, i.e., publications, technical support packages, workshops, demonstrations, applications engineering projects and industrial applications centers.

There are no plans to phaseout the program. The budget request reflects the policy determination to leave to the private sector those activities which can most effectively and appropriately be accomplished while maintaining an active, vigorous NASA role. During this period, we will be developing increased user and

industry funding support for technology utilization/transfer activities. Our progress in this effort and the economic environment will guide our decisions concerning the appropriate level of Technology Utilization activities.

QUESTION A-27:

NASA recently justified waiving the requirements of the Stevenson-Wydler Technology Innovation Act based on the Technology Utilization activities. How do you explain the conflict between this waiver justification on the one hand and the budget trend on the other?

ANSWER A-27:

The FY 1983 budget request provides for NASA Technology Utilization (TU) activities to be continued. As stated in our testimony, we are confident that we can conduct an efficient and effective program with the resources available.

In our waiver from the provisions of PL 96-480, NASA cited the pre-existing successful efforts which are meeting the intent of the P.L. 96-480 specific approach. We continue to maintain a Technology Utilization office at each field center, except NSTL in an appropriate organizational setting. New technology data is assessed and documented and made accessible to the private and public sector. We are continuing to publish NASA Tech Briefs. We are sponsoring a reduced number of technical applications teams, application centers, seminars and meetings with industry and users. In addition, NASA conducts many other activities in its R&D program offices and centers which can qualify as Technology Transfer activities and the FY 1982 funding for these activities exceeds the level required by P.L. 96-480. NASA will continue to evaluate its compliance with the specific provisions of PL 96-480 each year to assure that we meet the intent of the act.

QUESTION A-28:

I dare say the NASA Technology Utilization program is the Government's most effective program for contributing to increased productivity and innovation. Could you explain the logic for reducing this activity while at the same time supporting S.881, a small business innovation development act which would provide for set-aside of significantly larger resources as well as adversely impact ongoing programs.

ANSWER A-28:

NASA endorsed the objectives of S.881 in its testimony to the Senate Subcommittee on Innovation and Technology on July 15, 1981, and to the House Committee on Science and Technology on January 26, 1982. This is a Congressional initiative which has the endorsement of the Administration. However, the Technology Utilization program is not the only NASA program which contributes to small business activity. In FY 1981, small business participation in NASA's total procurements aggregated some $409 million or 9.6 percent of all prime contracts and some $474.9 million in subcontracts for a total of $884.3 million. This constitutes approximately 20 percent of total contract/subcontract awards to business firms. Of the 100 contracts

in FY 1981 receiving the largest dollar value prime contracts, 24 were small business firms. Therefore, we believe that NASA procurement initiatives offer convincing evidence that the resources of the small business community are progressively being utilized for the type of innovative research contemplated by S. 881.

QUESTION A-29:

The FY 1983 budget request for space transportation systems was projected to be $3,023,000,000 in March 1981 including a projection for Centaur development. The current budget request is $3,467,800,000 an increase of more than $440 million and does not include Centaur. Could you elaborate on the need for increased resource requirements for the Space Transportation System?

ANSWER A-29:

The current FY 1983 budget request for the space transportation system programs, which include the Space Shuttle, Space Flight Operations, and Expendable Launch Vehicles, is $445 million higher than the FY 1983 estimate in runout of the FY 1982 Amended Budget. This total of $445 million is comprised of increases of $187 million in the Space Shuttle; $243 million in Space Flight Operations activities; and $15 million in Expendable Launch Vehicles.

The Shuttle increase is primarily due to changes in three program areas: the $60 million included in the current FY 1983 budget request for the filament wound case development (there were no funds in the FY 1982 Amended Budget runout) to provide performance augmentation for the Shuttle; an additional $172 million for spares and equipment requirements primarily due to price and quantity increases for orbiter flight and crew equipment spares, External Tank and solid rocket booster rate tooling and External Tank producibility and production readiness efforts; and a $55 million reduction for Shuttle/Centaur modifications related to the decision to discontinue the development of the Centaur upper stage. Other increases totaling approximately $73 million have occurred in a number of Shuttle activities including systems integration efforts, post orbital flight test (OFT) data analysis, modifications to Orbiter 102, spacesuit hardware production, simulator/trainer modifications, and SMM mission unique requirements. These increases have been offset by an allocation of a like amount from the previous FY 1983 estimate for the Changes and Systems Upgrading budget.

In the Space Flight Operations line item, the increase of $243 million is comprised of increases of approximately $280 million for Shuttle Operations manpower and hardware; $17 million for multimission payload support equipment and manpower increases required for the upgrading of the Mission Control Center capability; and $15 million for Spacelab development for systems integration, flight hardware modifications and spares and ground support equipment. These increases have been partially offset by decreases of $60 million in upper stages development and operations related to the discontinuation of the Centaur upper stage development and $8 million in payload support operations requirements.

The Shuttle Operations increase of $280 million includes an additional $135 million for Johnson Space Center activities for

mission operations manpower and to procure orbiter vehicle spares and equipment which increased in quantities as well as unit costs, and a $115 million increase for Shuttle processing and launch operations manpower at the Kennedy Space Center. The manpower increases at both centers result from the requirement to maintain the current level of manpower as the STS transitions from development to the operational era. These levels of manpower established by STS-1 and STS-2 experience must be maintained until additional experience in operating the STS is gained and anticipated efficiencies are realized which would allow for reduced manpower requirements. Production of solid rocket boosters and External Tanks for operational flights have increased by approximately $30 million due to additional labor and subcontractor costs based on experience during the development phase.

Finally, the Expendable Launch Vehicle requirements have increased by $15 million for Delta vehicle procurement and launch services.

QUESTIONS A-30 and A-31:

What is the decrease in the FY 1983 budget request for space science activities compared to the March 1981 projection? What (if anything) has been cut? What is the decrease in the FY 1983 budget request for space applications activities compared to the March 1981 projection? What has been cut?

ANSWERS A-30 and A-31:

The FY 1983 budget estimate at the time the FY 1982 Amended Budget (March 1981) was submitted to Congress was projected to be approximately $714 million for Space Science and approximately $350 million for Space Applications. The FY 1983 budget request is $682 million for Space Science and $316 million for Space Applications, reflecting net decreases of $32 million and $34 million, respectively, from those earlier projections. Program and schedule adjustments have resulted in both increases and decreases among the individual projects. For example, the FY 1983 budget decision not to pursue the Centaur development and instead to launch the Galileo and International Solar Polar Mission on Inertial Upper Stages, required additional development effort (a kick stage and interstage for each mission) which increased the FY 1983 funding requirement for those projects over that projected in March 1981. The Venus Orbiting Imaging Radar mission development was not initiated and the Gamma Ray Observatory launch was slipped from early 1988 to late 1988, thus decreasing the FY 1983 budget request below the March 1981 projected level for these projects. In addition, several supporting activities have been reduced below the March projection in consonance with the budgetary constraints associated with the President's economic recovery program and NASA program priorities. Among the affected activities are Planetary Mission Operations and Data Analysis, Planetary Research and Analysis, AgRISTARS, Environmental Observations Research and Analysis and Shuttle Payloads, and the Airborne Instrumentation efforts. Communications data systems efforts and Materials Processing experiments have also been reduced.

QUESTION A-32:

I understand that the FY 1983 budget request is inadequate to support receipt of data from Pioneer spacecraft. Could you elaborate on this action particularly since the Pioneer spacecraft are returning data from parts of the universe heretofore unexplored? Would you agree that this action could be characterised as "arbitrary"?

ANSWER A-32:

A final decision has not yet been made regarding the Pioneer spacecraft, and we will make every effort to continue these operations as long as possible. However, NASA's FY 1983 budget request assumes that operation of the Pioneer spacecraft will be discontinued in January 1983. This was not an arbitrary decision. Our first priorities are to support the ongoing development programs, such as Galileo and ISPM. We recognize the scientific value of the Pioneer spacecraft; however, in weighing the missions to determine their priority in a year when we are also supporting the President's economic recovery program, some important efforts will have to be delayed or even terminated.

QUESTION A-33:

What are NASA's plans with regard to the Lunar Curatorial Facility?

ANSWER A-33:

A final decision has not yet been made regarding operation of the Lunar Curatorial Facility in FY 1983. We are reviewing alternatives to determine the best course of action under reduced funding, for example, mothballing the facility for a year, or significantly reducing the level of research and operations of the facility.

QUESTION A-34:

We understand you are planning to make a quid-pro-quo trade with NSF in which: (1) NASA would phaseout support of the Infrared Telescope Facility (IRTF) in Hawaii and would pick up from NSF support of a balloon launch facility; (2) NSF would reciprocate by supporting the IRTF.

a. Is our understanding correct? Has NSF agreed to pick up the IRTF funding? Do you have a letter from them? Could we get a copy?

b. Does NASA already have balloon launch facilities? Where? What is the rate of flight? Are the facilities overloaded with balloon flights? Is the budget for balloon flights increasing? In times of budget stringency, shouldn't we support more flights rather than more facilities?

c. What is unique about the facility NASA would acquire? Why is it needed? Where is it? How big is it? How many flights can it handle?

d. Do you have a plan for consolidating these facilities? Will you make it available to us? If you have no plan, why are you taking

on a new facility? Would you please consider such consolidation and provide us with a plan?

e. Have you decided to terminate supporting ground-based astronomy? If a policy decision has been made, how does this relate to other programs? That is, does "ground-based" include airplanes? Are you continuing your work in infrared astronomy research using airplanes?

ANSWER A-34:

a. There is no agreement with the National Science Foundation (NSF) for a quid-pro-quo trade of the Infrared Telescope operations for the National Scientific Balloon Facility (NSBF). The two items were discussed separately by the staffs of the NSF and NASA. NASA and NSF have been discussing the possible transfer of the operational responsibility of the National Scientific Balloon Facility for some time, as NSF's use of this facility has decreased over the last few years, and NASA needs the facility in order to accomplish an important part of our suborbital program. Negotiations between the NSF and NASA are continuing to determine who will pay for operation of the balloon facility in FY 1983.

NASA contacted NSF during the preparation of the FY 1983 budget request to see if NSF would consider operating the Infrared Telescope during FY 1983, because we believe that we may not be able to operate the telescope and at the same time support the President's economic recovery program. NSF, however, has the same problem and NASA is continuing to explore all avenues to support the telescope operations. We may have to suspend these operations for a year; however, a final decision has not yet been made.

b. NASA does not have its own balloon launch facility and has been dependent upon the NSF sponsored NSBF to launch its large balloons. No other facility with this capability and appropriate equipment currently exists. It is true that some small scientific balloons can be launched from Wallops Island, but these are very small in size and thus have limited instrument lift capability. NASA is currently the major user of the NSBF and without the continued support of NSBF, NASA would be forced to drastically reduce the number of balloon flight opportunities.

c. NSBF, located in Palestine, Texas, is the only U.S. facility dedicated to the launching of large research balloons. Several factors make it unique:

(1) The location, Palestine, Texas, is not in a major air traffic route. Thus, requests for FAA approval are relatively routine and quickly approved. In addition, the location was chosen to make the best use of atmospheric conditions which allow flights of 24-40 hours without danger of the balloon drifting too far from the launch site.

(2) The physical facilities, consisting of approximately 475 acres of NSF-owned land and several small buildings, are modern and well suited to the launch of very large scientific balloons. These balloons range in size from 5 million cu. ft. to 30 million cu. ft. (about 150 times the size of the Goodyear blimp) and require

special capabilities. NASA FY 1983 request assumes the launch of approximately 40-50 balloons during FY 1983. The total number of launches which the facility is capable of supporting involves several variables, i.e. weather, desired duration of flight, desired time of flight, etc, and cannot be simply expressed. However, the planned launch program is well within the capability of the facility.

(3) The 57 member staff of NSBF, which is largely comprised of engineers and technicians, has launched more large balloons with a greater success record than any other group in the world.

d. A draft plan for managing the NSBF is being prepared as negotiations with the NSF continues. When the negotiatons are completed, the Congress will be notified, and a management plan will be published. We will be happy to inform you of the details of the completed management plan.

e. NASA is continuing to support ground-based astronomy research in two areas. First, we are continuing an active program in observations of solar system objects as part of the earth and planetary exploration program and second, we are supporting some ground-based astronomy in direct support of our astrophysics missions. We are continuing to support infrared astronomy research using airplanes and balloons. Our suborbital programs support infrared astronomy research since these platforms provide the capability for testing infrared detectors and instrumentation at wavelengths not available at ground-based sites. The highest priority is placed on detectors and instrumentation research. The second priority is on theory and laboratory astrophysics research in support of our space missions, and the third priority is ground-based astronomy.

QUESTION A-35:

Is the science community pushing NASA toward flying simpler, less expensive planetary missions?

ANSWER A-35:

The scientific community has made it known that it favors a mix of missions, in terms of scope, for the earth and planetary exploration program. Missions that break entirely new ground, e.g., a first comet or asteroid rendezvous, will require new development and, thus, cannot be considered cheap. However, where the early exploration has already been completed, as in the case of the inner planets, significantly less sophisticated missions can be undertaken to address further scientific research.

QUESTION A-36:

In April 1981 the Subcommittee on Space Science and Applications released an oversight report on U.S. Civilian Space Policy. One of the recommendations requested that NASA submit to the Congress within 12 months a preliminary program plan for a Global Resource Information System utilizing an interactive network of relevant data bases including program scope, technology needs, and resource

requirements. What is the status of NASA's response to this request? When does NASA plan to submit this program plan?

ANSWER A-36:

The Information Systems Office of the Office of Space Science and Applications has been given responsibility for generating the preliminary program plan for a Global Resource Information System (GRIS). NASA is currently drafting a preliminary program plan for a global resource information system and plans to submit it to Congress in mid-1982.

QUESTION A-37:

According to press reports, the director of the Defense Advanced Research Projects Agency stated that the Department of Defense should assume responsibility for the Space Shuttle launch system. Are there ongoing discussions within the Administration with regard to this possibility?

ANSWER A-37:

Yes. The organizational responsibility for the management of the Shuttle in its mature operational phase is being addressed within the Administration. The focal point for this discussion is the Space Policy Study Group under Dr. George Keyworth, Director of the Office of Science and Technology Policy.

QUESTION A-38:

Could you elaborate on NASA's role in the space policy study being conducted by OSTP?

ANSWER A-38:

At the beginning of this study in September 1981, NASA detailed two key senior individuals to OSTP to assist in the staff work of preparing the space policy. These individuals, along with one detailee from DOD, have been the principal staff members leading the interagency space policy study. In addition, Dr. Mark is the senior steering group member and Mr. Culbertson is the working group member charged with organizing the internal NASA support for the study. A committee within NASA represented by two Headquarters personnel and one senior member from JSC, KSC, and MSFC have been formed to address specifically two major tasks of the study. These tasks are: (1) How should the space transportation system be operated in the future and (2) What launch vehicles are necessary for the future (mixed fleet issues)? The intent is that these two tasks will be worked jointly with DOD prior to submission to OSTP for incorporation into the space policy directive.

In summary, we feel that the OSTP space policy study is important for determining the Nation's future directions in space. We have organized internal to NASA to conduct the necessary studies; and, we have detailed key individuals to OSTP to assist in the space policy staff work. It is our intent to work closely with DOD to submit joint NASA/DOD policy statements on key issues affecting both NASA and DOD.

QUESTION A-39:

What is the status of the Space Transportation Company's (STC) proposal to the Government regarding STC's offer to provide funds to purchase a fifth orbiter? Is the proposal, in your view, complete or does it lack critical components?

a. What is your personal position on the proposal?

b. Are there other, similar industry proposals which the Government is considering?

ANSWER A-39:

The formal proposal of the Space Transportation Company to purchase and operate OV-105 has just been received by NASA. Prior to this receipt, we had access to only partial data. We are currently in the process of reviewing the formal proposal and identifying areas where additional or further critical information is required.

a. My personal position is that, while this is an intriguing proposal, the actual implementation of such a scheme would be very difficult. Priorities, Government rights vs company rights, and indemnification for a possible vehicle loss are just some of the extremely difficult areas that would have to be addressed. However, I am reserving my opinion until I have had more of a chance to study this idea.

b. To my knowledge, there are no other industry proposals which the Government is considering.

QUESTION A-40:

Last year, NASA testified that is was requesting $15.4 million in FY 1982 and projected a comparable amount for FY 1983 to carry out the Applied Research and Data Analysis element of its communications program. Further, NASA testified that their resources were essential to carry out its program which was designed to ensure the continued availability of low-cost communications to future generations of Americans and to enable the continued preeminence of U.S. industry in the face of mounting competition from European and Japanese government sponsored programs. Now, we see an FY 1982 operating plan and an FY 1983 budget that request $10 million and $5 million, respectively, for this same line item. Have we suddenly found a decrease in demand for the limited spectrum and orbit slots? Have Japan and Europe curtailed their efforts? Has NASA abandoned its plan to carry out a 30/20 GH_z communications program?

ANSWER A-40:

Demand for the limited spectrum and orbit slots continues, as does European and Japanese interest in developing new communications satellite capability. NASA is continuing long term technology development for use of the 30/20 geoplanetary band. However, the 1983 Budget reflects the Administration's view that greater reliance should be placed on the private sector for satellite

communications R&D, and that planning and funding for new satellites with commercial value is more appropriately and efficiently pursued by the private sector. NASA does not currently plan to initiate a technology demonstration program and the FY 1982 reduction is consistent with this decision.

QUESTION A-41:

What is the response of the user community--and I am speaking of businesses and public service agencies--to these reductions in the communications program?

ANSWER A-41:

Based on our conversations with representatives from the small business and public service industries, they are concerned. If the carriers do not pick up and develop this capability, small business and public service industries are afraid that competition for limited services will sharply increase the cost of these services.

QUESTION A-42:

What is the response of the carriers and the manufacturers who have worked cooperatively with NASA in the past to develop successfully the technology that has led to our present domestic satellites?

ANSWER A-42:

The carriers remain ready to pay for their own experiments and experiment hardware should NASA go forward with the demonstration program. To date, the manufacturers have not indicated that they will totally fund such a program.

QUESTION A-43:

With all the programs NASA has underway, it would seem that activities in the applications area could have some of the most tangible short-term payoffs for the country. If this is the case, why has this element of NASA's overall program been so drastically reduced in the FY 1983 budget?

ANSWER A-43:

The FY 1983 budget request was developed in support of the President's economic recovery program. The Space Science and Applications portion of the budget request assumes that industry will pick up those capabilities developed by NASA over the past several decades which have short-term payoffs. The budget reductions reflect a policy decision that Government-funded activities should focus on the more fundamental research and technology development, but that the specific development of the technology in commercially viable applications should be financed by the private sector.

QUESTION A-44:

Recent public statements indicate substantial increases are anticipated as a result of current space transportation system (STS) repricing exercises starting in FY 1986. Do you anticipate that you will be competitive with Ariane launchers available at that time?

ANSWER A-44:

In accordance with NASA's published Shuttle reimbursement policy, NASA will establish a new price for a standard Shuttle mission flown in FY 1986. The basis for the new price is currently in preparation for final review and approval. Our preliminary assessment is that the new price will be on the order of 75 percent to 100 percent higher than the fixed price of $18.27 million offered to users for the first three years of Shuttle operations. Although this increase is significant, the shared price charged users for a Delta class or Atlas-Centaur class communication satellite will remain competitive with Ariane.

QUESTION A-45:

Your FY 1983 budget request zeroed all systems technology programs aimed at civil aviation. What evidence do you have that industry will step in and carry on with these kinds of high risk technology development? (We have unanimous testimony that they can't.)

ANSWER A-45:

There is no solid evidence on either side of this question. The Administration's position is that when the industry perceives a healthier investment climate, and when it recognizes promising market opportunities and competition which demand products incorporating high technology, the industry will make the necessary R&D investments. Although we have heard the same statements you have regarding industry's unwillingness or inability to support research with long-term or uncertain returns, I believe it is far too early to predict what will really happen.

QUESTION A-46:

The Space Act was amended in 1976 and 1978 to involve NASA in carrying out both the electric and hybrid vehicle RD&D and the automotive propulsion RD&D acts. Do you plan to submit legislative changes to allow you to drop your work in these areas?

ANSWER A-46:

We do not intend to submit changes to the Space Act to delete the sections related to electric and hybrid vehicle R&D and automotive propulsion R&D.

QUESTION A-47:

In shaping your FY 1982 Operating Plan, have you taken any

actions that would preclude the Committee from continuing the zeroed civil avaition systems technology programs by simply restoring the funding in FY 1983?

ANSWER A-47:

With the start of the new fiscal year eight months away, we have not taken any actions which could not be altered to comply with Congressional decisions to increase the aeronautics budget. Obviously, the earlier these decisions are made, the easier it will be to avoid discontinuities in the transition to FY 1983.

By placing primary emphasis on continuation of a vigorous R&T Base program, we have maintained a strong foundation on which we can build additional systems technology activity when appropriate.

CHART A

AEROSPACE SAFETY ADVISORY PANEL
ANNUAL REPORT SYNOPSIS

FINDINGS

1. Design improvements are needed to make the Shuttle more compatible with operational turnaround.
2. With tight budgets and resulting delays of system improvements, it will be very difficult to achieve estimated 24 flights/year with 4 orbiters.
3. The R&D nature of current efforts, along with reliance on complex paper systems have nearly obscured the necessity for personal "on-the-floor" responsibility of supervision at all levels for safety and success.
4. Many details of doubtful importance are raised to the highest management levels for decision (bypassing the judgement of middle management and clouding the truly important issues).
5. The Panel believes that the incidents/accidents occurring demonstrate poor local supervision of specific procedures and a vague line of authority for essential tasks.

RECOMMENDED ACTIONS

1. Need to streamline procedures and processing requirements for turnaround.
2. Plan an orderly R&D and certification program for system improvements to create a more nearly optimum operational system (incorporate into future orbiters, SRM's, ET's or retrofit).
3. Conduct a major audit of the concept of redundant systems as applied to the essential elements of the Shuttle system.
4. Create a purely operational organization that would function like an airline or military mission command.
5. Establish a plan for continued performance flight envelope expansion to improve operational utility (needs to extend beyond the planned four (4) DDT&E missions).
6. "Redlines" (Launch and mission constraints) should be reassessed and then a rigid "redline" discipline must be achieved.
7. Logistics control is the key. Turnaround rates should be considered from the most optimistic viewpoint to the pessimistic (e.g., considering the possible grounding of one orbiter).
8. Review the specific systems for needed improvements (where the gain may be greatest).
9. Reexamine the readiness review process including: Safety, Reliability, and Quality Assurance organizations being more clearly in the decision loops, and the simplification and reorientation of safety/risk assessments to identify the issues that truly need top management attention.

AREAS OF CONCENTRATION

1. An assessment of adequacy of internal technical audit functions.
2. An examination of systems redundancy concepts for such subsystems as: hydraulic power; flight controls; main engine thrust control; computer systems; electric power generation and distribution; communications and data transmission.
3. An assessment of the safety implications of the transition from DDT&E to operations and the use at KSC of a single Shuttle processing contractor.
4. Review concepts for "Upper-Stage" propulsion systems and lightweight ET's/SRM's.
5. Review specific critical systems for needed improvements: landing gear; SRB thrust vectoring; cockpit/crew station design; flight controls, TPS, use of common non-hypergolic propellants.

Mr. FLIPPO. Thank you very much for that statement. We certainly will include the entire statement in the record.

Since no one has objected, without objection we will permit filming since we have been from the beginning. It does require unanimous consent, so I think we should address that.

Mr. Beggs, since you and Dr. Mark have been on board and since this is the first budget that you have put together, can you tell us anything about your feelings about the morale of NASA people throughout the agency at this time?

Mr. BEGGS. Morale is an elusive kind of thing, Mr. Chairman. It is one that I have been concerned with in every organization that I have been in, including, of course, NASA. It is uppermost in my mind. For that purpose, both Dr. Mark and I made visits to each of the centers when we came on board. I have visited all of them, as I believe Hans has. These visits were for two purposes: One, to let them get a look at us, and to hear from us as to what we thought we were setting about; second, to try to get a feel of what their morale was and to ask questions to see what they thought the future of the Agency should be.

My feeling at that time was that in several of the centers morale was low. I feel that is the result of a number of factors which have been working for the past several years. Budgets have been coming down in real terms. The future of many of the programs was cloudy. The effect of slips in the Shuttle program and of the problems that cropped up in that program in the past have all, I think, had a detrimental effect on the morale of the Agency. I think that that still exists to some extent. However, I believe we discern an improvement in the outlook of the Agency. I think the fact that for the first time in several years the budget represents a real increase in spending power helps, which, of course, is always good news to scientists and engineers who are involved in hardware programs, because in looking forward to the future they are always looking at new projects. If you are looking at a declining budget, you have a real problem in trying to plan for the future.

I would hope with the changes we have made in organization, trying to shorten the lines of communications, as well as the Shuttle moving toward operational status, coupled with the fact that each time we fly there is a very great emotional uplift not only to our people but I believe the whole Nation, that morale will continue to improve. I assure you it is something on which we will be working.

Mr. FLIPPO. Would you elaborate a little for us on NASA's plans for planetary exploration activities and how the cancellation of the Venus orbiting imaging radar might fit in with those plans? Could you tell us a little something about the impact on the Jet Propulsion Laboratory in California as a result of the cancellation of VOIR? Perhaps you would care to comment on whether or not there are any discussions regarding the transfer of JPL from NASA to the Department of Defense.

Mr. BEGGS. In looking at the future of the planetary program, there were a number of issues that had to be examined. One was the question of flying out the current series of planned missions: Galileo and the continuance of the monitoring and receipt of information from the Voyagers which are still flying. We are still get-

ting an immense amount of data from the very large and very significant programs which were begun well over a decade ago and continue to this day. I think they have been an inspiration to all of us as we watch the flyout of those missions.

It was felt, however, that at this juncture it was time to reexamine the aspects of future exploration. The feeling among a lot of very involved people in this program was that we have flown a lot and we have gained a lot of information. As a consequence of that information, we have raised a lot of questions that need further exploration and further development. Therefore, it was decided that we would go back and do some studies to examine the future of the planetary program, not with an eye to terminating it, but with an eye to looking at more specific missions—rifleshooting instead of shotgunning—to try to answer some of the more specific questions. It was also felt that those missions could be flown at lower cost per mission; thereby, allow us to do more in answering the unanswered questions and perhaps put it on a basis where we could continue the program at a budget level that we could sustain for a long, long time. That really is the purpose of this budget. The studies are ongoing. We have the concurrence of Dr. Keyworth in making those studies. This Office is participating in them. I think we will come up with some very interesting possibilities for the future.

The issue of JPL, of course, has been one that has been with this Agency for a long time. I can recall the last time I served NASA, about 15 years ago, that we were discussing JPL's future. Lo and behold, I come back in the Agency and we are still discussing the future of JPL. JPL is the repository of most of the technical expertise and program management for our planetary program. It is an immense national asset; therefore, the last thing I want to do is to disband that. The question occurs though as to whether, within the constraints of the planetary program we have laid out, we can support fully the whole laboratory. Our conclusion was that the expertise they have could be applied in some other areas.

We fully intend to keep JPL occupied to a major extent and with the majority of their people on missions like Galileo. I should mention that VOIR was a mission that had not yet gotten to the point where it was employing very many of the JPL technical people. It was primarily a contract activity at this point, but it would have developed into a major activity out there in several years. What we have said to JPL is to join with us in studying the future of planetary exploration and let us come up with a plan. We have lost VOIR, but that does not mean we have lost the planetary program. We have begun those investigations. I think JPL will continue as the center of this Nation's exploration activity into the foreseeable future.

At the same time, the management of JPL has entered into discussions with elements of the DOD to apply their expertise in areas where the DOD needs help. We support that. We think it will be an activity in which they cannot only contribute to work that is going on in elements of the Department of Defense, but they probably can do it better than anybody else in this country. We think that is important. It will not be the major activity out there at any time. It is possible that it could build up to perhaps a quarter of the laboratory or even as high as a third, but I doubt that it will

ever grow any larger than that. In fact, I doubt that it will grow that large. They are exploring the various and sundry activities which have been suggested to them. They already have a small project they are working on out there. We do not intend to spring it out of NASA to any other agency, including the DOD.

Mr. FLIPPO. Thank you.

Mr. Hollenbeck?

Mr. HOLLENBECK. Thank you, Mr. Chairman.

Mr. Beggs, as I see the budget request, we have no funding for the fifth orbiter. I would assume that because of this some of the subcontractors would begin closing assembly lines for long lead procurement items. There are a number of people who are of the opinion that a fifth orbiter and maybe a sixth are essential. I wonder if you can comment on that and on the question I raised in my opening remarks as to the private sector possibly becoming involved or interested in this.

Mr. BEGGS. Yes, sir.

We do feel that there is probably a need for a fifth orbiter. We have begun discussions with the OMB on that subject. The Congress, as you know, had suggested to us that we examine the possibility of block buying the fifth one with the fourth one. That is still an option that we are examining.

In direct answer to your question, we have, I believe, until this summer to bring together a business proposal which will enable us to block buy the two orbiters and perhaps save some money and improve schedules. According to our prime contractor, we still have sufficient time with respect to our subcontractors and material suppliers to work that option. We will be working it very hard.

With respect to the various proposals that have been made for the potential of operating in a private sector environment, the only thing that we had prior to this was several informal discussions with a number of different people, including one organization that has been pursuing this very aggressively.

As of yesterday, I believe, we did receive a proposal. That is the first time we had a proposal which outlines the terms of their participation in the purchase of the fifth orbiter and later operation in the marketplace to sell that capacity. We have not had an opportunity to study it as yet, but we will.

I welcome the opportunity presented by that proposal to reexamine this whole issue of how one goes forward with the future of the whole orbiter fleet. I think there is the potential of some private participation in this. Whether it is on the basis that has been outlined in the current proposal or some different basis is something I think we ought to look at very seriously. We will be doing that.

Mr. HOLLENBECK. Thank you.

Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Glickman?

Mr. GLICKMAN. Thank you, Mr. Chairman.

First of all I would like to thank you for your testimony and secondly indicate that I believe you two gentlemen—particularly you, Mr. Beggs—have, in fact, done what you can to preserve a lot of NASA's important programs, including aeronautics.

Let me ask you this: In this year's appropriations bill, Congress apparently gave the agencies some discretion in cutting up to 5

percent within their specific budgets. It looks to me as if what NASA did was to essentially protect all of the Shuttle operations and take the cuts out of all the remaining operations including space science and particularly aeronautics. Is that a fair statement of the priorities of NASA within its total budget?

Mr. BEGGS. Yes, sir. Let me put it this way: It is not unfair. Our interpretation of the 5-percent cut is that there was discretion to move the resources around. In our view, what we did was to move the resources around in such a manner as to work our way into the decisions which had been made for the 1983 budget request. I think if you look at the 1982 plan with relation to the 1983 submission, they are in consonance. That was the basis of the resource allocations we made.

Mr. GLICKMAN. OK. Now given that plan—which I guess represents the desire of this administration to go ahead and proceed with the Shuttle but meaning that you are going to have to cut everything else—your fiscal 1983 budget request zeroed all systems technology programs aimed at civil aviation. You have kept some in there, for example the low speed aircraft systems technology and the high speed aircraft systems technology. It is my understanding that those relate significantly and predominantly to military applications.

My question is: What evidence do you have that industry will step in and carry on with these kinds of high risk technology developments that in fact the Government and NASA have traditionally been involved in?

Mr. Winn mentioned this before. In fact NASA has been involved with research in a variety of areas: propulsion, materials, structures, and perhaps some new areas, too.

It worries me because our competitors are in fact going ahead with some of these programs.

Mr. BEGGS. The policy position we took with respect to the aeronautics budget was that we would continue the basic work and the technology development work, but we would terminate the work, as you have stated, in the hardware development and what I would describe as validation of technology. That position was taken because we felt that we should try the industry out to see whether they will pick that up. We believe that they can. They are capable of doing it and we believe they will. However, as you said, it remains to be seen; but, we are putting them on notice that this is where we stand.

The basic technology work and the development work that relates to the bringing on of new concepts will continue. You cannot separate that as between military and civil because the aeronautics work in particular relates to both. One never knows where it is going to be applied or where its first application will be. I will yield to no one in my desire to maintain the United States at the forefront of aeronautics. It is enormously important and I believe in it. We think the budget we have put together will sustain that. It obviously is not all that we would like to spend if we had a budget that was larger, but we do believe we have a sound program that will sustain the leadership position.

I think the basic issue is whether the industry will indeed pick up the validation work and carry that on. If they do not, if they

cannot, or if they make a persuasive case that they cannot, then, I think, we will have to re-examine that policy. I might add that to date we have not received a very strong input from the industry that they will not.

Mr. GLICKMAN. We had some hearings here in this very room where we had a strong evidence from a cross section of industry that they wanted to see the programs continue. Are you aware of that?

Mr. BEGGS. Yes, sir, I am.

Mr. GLICKMAN. I am glad to know that you have an open attitude because in fact our international competitors seem to be much more aggressively involved in aeronautics research and development than they ever were before. There is a great deal of Government help behind their efforts and I just do not want to see us slip behind.

One final question: Mr. Flippo asked you about the Jet Propulsion Laboratory. As a result of the cuts in 1982 and the new cuts of 1983 are any facilities that NASA currently operates going to be closed, either JPL or the Lewis Center in Cleveland? Are you aware of any facilities that are going to be closed?

Mr. BEGGS. No, sir, I cannot think of any major facilities at any of our centers that are going to be closed.

Mr. GLICKMAN. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman.

We hear quite a bit of talk these days, Mr. Beggs, about the cutting back on the budget of DOD. There is always a lot of criticism about duplication, overlapping, waste, and so forth in that agency. There are some of us that agree with that contention and that some of the money they are asking for should go to try to save money by preventing that, including procurement.

Is there anything cooking at NASA, any program that is looking seriously into procurement procedures, duplication, waste, overlapping, anything of that type?

Mr. BEGGS. Yes, sir. We started several activities. We are, of course, concentrating on the program which has the biggest impact on the Agency—the Shuttle program. As you mentioned in your opening statement, it is the big consumer of funds and well over half of our budget will go into that program.

We have started several activities looking toward improving our contracting with our prime contractor as well as with a number of other associated contractors. The intent is to try to put the incentives in the right place and to try to make them more efficient in their operation. I mentioned the examination of the block buy concept at which General Abrahamson is looking at very carefully and in great detail. We are trying to improve productivity within our programs both at the contractor facilities and at our centers. We are looking for various ways to improve the efficiency and economy of our operation at KSC which is motivated by a lot of different factors. Not only do we want to be more efficient and operate economically, but we now have a very significant competitive challenge from abroad. The Europeans have entered the launch serv-

ices market and are offering their service at a very competitive price. It is a good pressure and I welcome it.

We are examining our operations at KSC to see whether we can work out a program to start reducing the number of people. You do not save money unless you get bodies off the job. We are also examining broadly the way in which we write contracts from an incentive point of view; this is an area where we can make some significant improvement from the way we operated in the past.

In short, I think we have a good program going. It is a broadly based program to try to improve efficiency and to reduce the amount of dollars that we spend on any one activity. I believe this Agency has been very well managed in terms of the way it spends its money. That is not to say we do not make mistakes, we do. However, overall, I think if you examine the past, NASA has done a good job of spending its money. This is a new period, we have new pressures, not the least of which is competition and we have to do better.

Mr. WINN. Have you looked into the possibility of value engineering?

Mr. BEGGS. Yes, sir. It is one part of the productive work that I mentioned to you earlier. It is a very useful technique in certain situations, one that I am very familiar with from my fairly long experience in working it from the industry side. We will be looking to see how we can employ this concept in NASA contracts.

Mr. WINN. Is NASA looking at alternatives to the various planetary missions? For instance, is there a cheap VOIR spacecraft that could meet many of the goals proposed by the agency?

Mr. BEGGS. Yes, there is a mission which, we think, could yield almost the entire VOIR results with a simpler and much cheaper system. However, I really do not want to get on the record as to what specifically we would propose in that planetary program. I think we still have to do a good deal of soul searching and examination before we put down a program in great detail. There are identified ways of flying these missions at lower costs. The systems are somewhat simpler. They do not give you all of the results; but, they give you the bulk of the results.

Mr. WINN. My last question, Mr. Beggs, is how is the Vandenberg launch site progressing and are there any other unforeseen problems that have surfaced out there? Is weather a problem at Vandenberg?

Mr. BEGGS. Let me just comment briefly. Then I would like Dr. Mark comment since this is his field and he just came from the Air Force.

We are satisfied with what the Air Force is doing at Vandenberg. We were a little worried about it 6 months ago because they did project and take a slip. However, with the discussions we had with the Air Force at that time and subsequent to that, they now have a very solid plan and they are moving out on it. I think they will remain on the current schedule and that will sustain the launch schedule that has been projected.

Overall, I think the current situation vis-a-vis the Air Force development and our joint program to insure that both the east and west coasts are ready on time, is progressing satisfactorily.

Hans?

Dr. MARK. Mr. Winn, there are two specific things that I could add to what Mr. Beggs has just said. One is that there is now a much closer collaboration between the Air Force and the NASA elements involved in this aspect. We have a standing committee with General Henry for the Air Force Systems Command and Jim Abrahamson for NASA, as well as a third member. We are also looking very closely at having the Kennedy personnel, who have already made the trip through the woods once with respect to getting a launchsite going, work with the people at Vandenberg to help them in their efforts.

Mr. WINN. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Mr. Fuqua?

Mr. FUQUA. Thank you, Mr. Chairman.

Mr. Beggs, back in 1979 and 1980 we had some problems with NASA and the committee with schedule and cost problems. The committee, particularly the subcommittee, spent a considerable amount of time in reviewing that and we made some recommendations to NASA that probably some of the senior staff at NASA should review some of the management procedures and procurement requirements and update some of those if they found it necessary.

Have those recommendations been implemented? What are your general thoughts?

Mr. BEGGS. The culmination of the response was the Hearth report in which Don Hearth, Director of our Langley Research Center, put together a group to study the procedure. He made a number of recommendations. A lot of those recommendations are ongoing things. They are things that one has to put in the system and continue to work.

For my part, we have formalized the recommendations. We have issued a NASA management instruction implementing the Hearth recommendations in some detail. I have sent a letter to each one of the Center Directors in which I describe, in my words, what I think program management and contract administration should cover and what they should do. We have a system of reviewing this. I believe that as a consequence of the latest review that we are making good progress. I mentioned some of the things that have been done within the Agency to try to improve the management practices and the contract administration as well as to start a broad program of trying to increase our efficiency. I think the results of that effort will start to show within the next 6 months or so. This is not some thing in which you produce large results overnight, but it does work over time.

I think that we are seeing a very good response from our contractor force. The contractors have all come in and said, Look, if you put the incentives in the right place, you can be sure we are going to respond. We are more than willing. We are eager to improve the activities, recognizing as we must that where they have been for the last 10 years is working very difficult technical problems which require the kind of environment that they were working in.

Now we are proceeding to a new era. They are eager. We are eager. I think the results of the Hearth report will start to bear fruit this year. We will see more improvements as time goes on.

Mr. FUQUA. Very good.

What is the total number of emplcyee strength and civil service strength that will be affected by this budget?

Mr. BEGGS. The short answer to your question is that it is down 433 full-time equivalent man-years.

Mr. FUQUA. For man-years?

Mr. BEGGS. Yes, sir. I am having a little bit of trouble with this since it is different from the last time I was trying to hold this situation under control. The actions you take are different when you are dealing with full-time equivalents. Where we come down to at the end of the year is 21,000 in full-time equivalents. The result of the full-time equivalent control is that you have to manage from day one through the year if you are going to come to that exact total. If you wait too long, you have to drop significantly below that in order to reach the full-time equivalent number.

Mr. FUQUA. How does that project into the out years of 1984 and 1985? It is my understanding that that administration is proposing to reduce by 75,000 total governmentwide, but how is NASA affected?

Mr. BEGGS. Our current understanding and agreement is that the 21,000 will be constant. My concern in looking at the numbers originally is that we were cutting into some muscle in places if we were to reduce much below that. I think we have general agreement with the OMB that this is a number in which we and they can live. It permits us to do the things that we need to do. I think it is about the right number. Obviously there is no right number, but it is as close to being in the right ball park as, I think, you can come under this kind of a management structure.

Mr. FUQUA. The NASA program will level at the 21,000 man-year equivalent?

Mr. BEGGS. Yes, sir.

Mr. FUQUA. In the out years?

Mr. BEGGS. Yes, sir.

Mr. FUQUA. This may get more specific when General Abrahamson testifies later, but a flight rate of 24 per year I think has been projected. Are we going to be able to meet that schedule without large additional expenditures as has been mentioned by some, particularly for the external tank requirements?

Mr. BEGGS. Let me preface the remarks this way. We have to achieve the learning curve projections that we made in all the elements of the system in order to achieve that 24 flights-per-year rate. If, however, we can get on the learning curve and stay on it, we can probably go higher than that.

In examining the details of the buildup to that 24-per-year rate it appeared to us that projecting more than that would be taking more risks than we should. Moreover, we felt we could satisfy the demand with a 24-per-year flight rate. However, we recognize that it may be necessary to go up higher than that. We have to find out whether we can get on the learning curve and stay on it. That means both costs and manpower and schedule. All of those things are affected by our ability to learn.

Mr. FUQUA. About what timeframe will that curve start to move?

Mr. BEGGS. It varies by element. We will be taking delivery of the first lightweight external tank, the T-1, which is the first unit

on the curve for the tank, early this year or midyear. The objective is to start from that point and to move right down. Our contractor believes he can do better than the curve that has been projected. I hope that he is right. I hope we have been conservative on that. As you know, the external tank is a key element in projecting the increase to 24. If the contractor can better his learning curve, it means we will be able to produce more for the same expediture level each year.

In the case of the solid rocket boosters, we are proposing to enter into a filament wound case program. Both the contractors who will be competing for that job, assuming it goes forward, feel very strongly that the filament wound case will be easier to produce and will be cheaper than the current steel case that we are buying. I hope that is so because this is another critical activity that we must worry about as we increase to higher flight rates.

With respect to the orbiter, we have a lot to learn in the next couple of flights in terms of turning it around. I should say that the good news is that on the last flight the orbiter came back in a condition where I would have been very comfortable, if we had an emergency situation, in flying it again almost immediately. I think we could have turned that vehicle around within a matter of weeks because it was in very good shape which is very encouraging. Nevertheless, we still have a situation at KSC where we are employing lots of people, and working a lot of overtime in doing what will have to become very routine tasks in preparing the orbiter for flight.

The orbiter came back in November. We are hoping to fly it in March. That is a significant improvement in time. When we get it back in March, we are hoping to fly it again in July, which is a further improvement in time. If we make that schedule, it is going to give us a lot of confidence that we can continue to come down the learning curve relative to turning the orbiter around.

Whether or not we are going to be able to achieve the projections that were made earlier, I think the jury is still out on that. We are going to have to worry about the turnaround time. That is the reason we began some months ago to start to talk to our contractors to see if there is a better way of doing this job and suggesting that a group be put together to study it with us to see whether we can agree that there is a better way to contract for and manage the job.

We now have several contractors who are working with us during the period of preparation for STS–3 in trying to assess how we could do that job better. I think this effort will result in some recommendations in both the way we contract and the way we operate and should enable us to improve turnaround time even further.

Mr. FUQUA. Thank you.

Mr. FLIPPO. Would the gentleman yield on that point?

Mr. FUQUA. I have used my time.

Mr. FLIPPO. We will come back to this a little bit later. With regard to your capital outlay plans for external tanks, for the solid rocket booster processing facility, for any additional launch pads, or for the mobile launch platform, it would be helpful if you could supply for the record starting times for those capital outlays.

Mr. BEGGS. Yes, sir.

Mr. FLIPPO. Mr. McGrath?

Mr. MCGRATH. Thank you, Mr. Chairman.

Mr. Beggs, I am going to see if I can structure these questions in a concise manner so that we can get a concise answer so that I can get all of my questions in.

First of all I want to make a comment on the question that Mr. Hollenbeck raised regarding the fifth orbiter. I was less than happy and enthralled when I had to read in a magazine article about a proposal which was somewhat fairly well down the line.

I am trying to get a sense of the intensity of the commitment of the administration and the clout of your agency on this particular question. What was your original budget request to the OMB?

Mr. BEGGS. You are talking about the total budget for the agency, sir, or for the fifth orbiter?

Mr. MCGRATH. For the agency.

Mr. BEGGS. $7.6 billion.

Mr. MCGRATH. You got $6.6 billion and change. How many appeals did it take in order for you to get $6.6 billion and to whom? Did you have to go all the way to the President?

Mr. BEGGS. I think basically it boiled down to three. No, we did not go all the way to the President. We went to the Budget Review Committee which resulted in some further discussions until we reached the $6.6 billion.

Mr. MCGRATH. OK. I understand that $5 million in the 1982 budget has been reprogramed to the Shuttle. Are we going to be looking at a supplemental for the Shuttle in 1982?

Mr. BEGGS. I do not believe so.

Mr. MCGRATH. Thank you.

We have had two demonstrations of successful flights of the Shuttle. At some time in the past there was a prediction that we could do it within a 2-week turnaround time. Has there been any reassessment about realistic turnaround times based on our two demonstrations?

Mr. BEGGS. Let me try to clarify what we were planning. We are operating a fleet of four orbiters. We were projecting a buildup to 24 flights per year. That says that the four orbiters on an average will fly six times a year, which is once every 2 months. Obviously you cannot do that kind of planning because you have to count on the fact that you will have some modification or repair work on one of the orbiters at any one period of time. Perhaps flying each of them once every 6 weeks is a more reasonable estimate of what we will do.

We would like to anticipate the day when we could turn them around faster than every 6 weeks, perhaps once a month. If we could get to the point of turning them around faster than that, obviously we would be in very good shape, assuming the market develops as a lot of us expect it to and the payloads are there to fly. The prospect of getting down to those kinds of turnaround times, that is once every month or 6 weeks, is still pretty good. However, it is going to require a major improvement on the way we are operating at KSC. We are going to have to improve the way we operate within KSC facilities very significantly.

Right now we are going to be facility limited, which is to say that we will be stacking solid rocket boosters in the vehicle assembly building and we will not be able to work on a second stack which may be in there at the same time. We have to find a way to improve that. As I mentioned earlier, we are trying to figure out how we will do that.

The orbiter itself continues to look good which is encouraging. It is coming back in very good shape and that leads us to believe there will come a time when we can probably refly this bird with relatively little work on the major systems. We think we will eventually get to the point where it will come back in flyable condition.

Mr. MCGRATH. Very good.

I am interested in a change in the budget, seemingly a change in philosophy, if not policy, from last year's budget. We had hearings regarding the upper stage versus the Centaur. I understand that we have made a decision to change based on what I see in this year's budget. I am wondering what prompted that change.

Mr. BEGGS. We were requested to do a study on Centaur versus the Inertial Upper Stage with the Department of Defense and to assess the need for Centaur. The outcome of that study was that while the military did say that there were some requirements in the 1990 time period, when they would need a high energy upper stage, there was no requirement now. That result meant that the Centaur that we required rode only on two missions—the Galileo and the International Solar Polar Mission.

In our budget discussions, it was felt that the $300-odd million that it would take to put Centaur in Shuttle, considering the fact we only had those two missions and the military had no near-term missions, could not be justified.

Mr. MCGRATH. Versus what cost for the new upper stage? It was $300 million versus what?

Mr. BEGGS. The IUS is over its major expenditures now. Deliveries are starting. The cost projections are in the $50 to $60 million per copy range. The Centaur would have been cheaper, Mr. McGrath, but the problem was it was hard to amortize that big front end cost over the very limited number of missions. While the Centaur stage would cost less per flight once developed, when the upfront cost was amortized over two missions, we could not justify it.

Mr. MCGRATH. I am sure Mr. Lowery will have some other questions regarding that particular subject later.

Regarding the reduction in funding in your operating plan for 1982, I am just wondering what is going to happen to programs like life sciences, space applications, space research and technology, and tracking and data acquisitions. What is going to happen to them since they have been somewhat reduced or eliminated in favor of the Shuttle?

Mr. BEGGS. I do not believe any of the ones you have mentioned have been eliminated from the program in the 1982 budget. There are some that have been reduced to some extent. The Life Sciences area is in reasonably good shape. In space applications, while it has been reduced somewhat, we still have an operating plan which anticipates spending over $300 million in that program. I can deal with the other areas if——

Mr. McGRATH. My question is: You came in—well, not you specifically—last year with a budget and gave good reasons for the numbers you needed in those particular programs. I understand that the Shuttle is a problem, but why those particular programs as opposed to anything else?

Mr. BEGGS. Why the decisions we made? There were two bases for the decisions. One was the policy basis where for whatever reason it was felt that a particular activity could be passed to the private sector, we did that. The other was purely a question of cutting where we felt we could afford to cut and not cut muscle, which is to say we cut things which we felt at some future time if it was necessary to reinitiate, we could reinitiate. We would have lost time, of course; but, we would not have lost the technology or the science.

Obviously we would like to spend more. So would everyone in town. We were constrained. We tailored this budget in light of those policy decisions and also in light of the decisions that we knew were upcoming in the fiscal year 1983 budget.

Mr. McGRATH. One more fast question related to Mr. Winn's question regarding the problems, if any, at Vandenberg: We understand that there is talk about the construction of a wind screen because of wind and weather problems. What are we talking about in terms of money? Does that constitute any real problem for us?

Mr. BEGGS. There is an examination of the wind screen problem which Dr. Mark has reviewed deeply. I will let him respond.

Dr. MARK. The wind screen is actually a sheetmetal building that surrounds the stack of the orbiter, the tank and the solid rocket boosters. It is budgeted now for about $40 million. Our feeling is that it is really essential to provide an environmental shelter during the mating process of the orbiter with the rest of the stack because of the tolerances required in that process. The mating procedure was originally designed to be accomplished indoors which is the reason for the building.

Mr. McGRATH. Thank you.

Mr. FLIPPO. Thank you.

Mr. Nelson?

Mr. NELSON. Dr. Mark, could we help solve part of Mr. Glickman's problem on the diminishing resources going into aeronautical research by shifting more of it to the Department of Defense?

Dr. MARK. Is that question addressed to me, sir?

Mr. NELSON. Yes.

Dr. MARK. I do not think so. Let me again repeat what Mr. Beggs said. The aeronautical program was constructed where all the basic research and development necessary to stay in the lead in aeronautical technology was preserved. We also preserved those systems technology programs, those demonstration programs that had direct relation to military work.

Mr. NELSON. Did NASA pay for those?

Dr. MARK. Yes, sir. Sometimes they were joint. For example, in the case of the rotor craft program we have joint programs with the Department of Defense. In the case of the Navy, we have a strong joint program where the Navy's contribution is substantial.

Mr. NELSON. How about the B-1-B?

Dr. MARK. That work is done for the B-1-B. In the case of the B-1 bomber for example, NASA put in 26,000 hours of wind tunnel time in NASA facilities. As you know, that work is done essentially free because of the law under which most of those facilities were constructed.

Mr. NELSON. Free to the military?

Dr. MARK. Yes, sir, free to the military. The law under which the planned wind tunnel system was constructed requires us to provide free time for those programs related to national defense.

Mr. NELSON. Mr. Beggs, you mentioned keeping your employees at about 21,000. As you move into this phase over the next several years basically at your launch point, that is, KSC, of bringing everything down into three contracts, when you finally get to the cargo processing contract do you envision contracting that all out, or are you going to have NASA employees within that 21,000 figure continuing to work on that?

Mr. BEGGS. I think there will always be the Johnson and Kennedy involvement in the cargo processing area. I think that will be essential if for no other reason than to assure our customers that they are getting the service they deserve. We are moving into a period when we are going to be very much in a marketing mode. This is kind of a new role for NASA. It is coming a little hard in some places to get in that mode, but, as a consequence of that, NASA employees are going to have to remain involved in those activities.

Our endeavor at Kennedy in those three contractual activities you mentioned is to try to find a way of getting the contract support in the most efficient way we can. We feel that there is currently some duplication. There are some cases where scheduling is difficult between contractors because one contractor schedules a certain activity and that precludes another contractor moving into that area and doing what he needs to do. That clearly needs some consolidation and coordination.

Mr. NELSON. There is no attempt that you see with regard to that cargo processing contract that it would have more civil service employees working on it than the other two contracts?

Mr. BEGGS. Proportionately I do not believe so, Mr. Nelson. I think the jury is still out on that one though. I hesitate to get on record as saying there has been some definitive decision because that is the one contract that is the least well defined among those three.

Mr. NELSON. OK.

Mr. BEGGS. I think we have a lot of work to do to decide what the division of labor is in that case.

Mr. NELSON. OK. We are down to projecting 24 flights a year for the foreseeable future when we get it up and running. Where does this leave us from a competitive standpoint for commercial users? Obviously we are not nearly as competitive as we once thought that we may be but are we still competitive on out to the end of the decade? What are your projections?

Mr. BEGGS. Looking at the market, and I have stared at this very hard for the last 6 months since I got into town, it appears that 24 flights per year will satisfy the current projected market demand.

Mr. NELSON. Up until what year?

Mr. BEGGS. I think probably through 1987 but again, I would hate to be pinned to that particular date. It could be that after we start flying—as you know, we have not started really flying for hire as yet—when we start flying and the benefits of those flights become obvious, and if some of the industrial applications that are projected would pay off big there will obviously be a faster build-up in demand. However, you know 3 years is a short time horizon in this business, and certainly through 1985 into 1986 we are covered adequately because we are manifested through 1985.

If further demand should come up as a result of some of the industrialization ideas, then we would have to go back and say we have to figure out a way to get up faster to the 24 and to plan to go beyond 24. Current planning says that that is going to be enough. It also looks like that gives us incentive to start working on getting the cost per flight to the level which we have been projecting.

Mr. NELSON. At 24 flights a year, what is that cost per flight?

Mr. BEGGS. I do not know. I wish I did. I honestly do not know, and this is one of the things that we are working on very hard. The first thing that I did when I got back was to sit down with the centers and the folks at headquarters and look at the question: What do we know about our costs?

We know a lot. We have projected learning curves and we have projected our costs. If I were to believe everything that I have on paper, I would answer your question by saying that I think we can achieve a cost-per-flight in the 1985 time period in the $75 to $80 million-per-flight range. But—and this is a big but—we have yet even to get to the theoretical first unit cost (T-1) on those learning curves. In many cases, we have not yet put the first point on the curve. Therefore, it would be the height of folly for us to say that we know what our costs are because we really do not. This is not to say we cannot tell you how much money we are spending. We can tell you to the penny, but, in the sense of projecting production costs and operating costs on a system which is operating routinely 24 times a year, we cannot do that yet. I hope to be able to do it though within a year, at least to have a figure which is close to the ball park. Within a year we will have all those T-1 points on the curve. We will have some idea of how well they are coming down that curve, and I think we will be able to tell you more accurately whether we are going to meet that $75 to $80 million per flight, which incidentally would be a very nice figure.

Mr. NELSON. What was that figure?

Mr. BEGGS. Seventy-five to $80 million per flight in the 1985 time period. That would be a very nice thing to achieve and, I think, very competitive with any of the alternate systems.

Mr. NELSON. Let me ask you this: I personally believe that we need a fifth orbiter. Can you supply me with the argument that I can use on my colleagues as to the need for a fifth orbiter if we are only launching 24 a year?

Mr. BEGGS. I can give you several arguments. The first one, and the one that I think is most compelling, is that we have bought four and we know we can use four. In almost any well-ordered transport program, for example, in the commercial world, there is always an extra airplane or an extra system bought in order to provide for attrition. The military in any of their systems always

buy some attrition machines because they know they are going to lose some.

Now, I do not want to say we are going to have an accident, and I hope and pray that we will not have an accident; but it is possible that we will ding one of these machines from time to time or go into an extended modification. Therefore, it would be very comforting—indeed, essential—that we have a backup vehicle. If we are going to have a backup vehicle and if we are going to protect ourselves, we really ought to get on with that some time in the next year because we will start to lose our subsystem subcontractors in that time period. Once they go out of business, literally we will have to go back and redesign or reprocure different systems because they will not be available.

Mr. NELSON. Mr. Chairman, let me just mention something in passing: I would appreciate it if you and Dr. Mark would take a look—in your attempt, as articulated in your statement to cut down costs and so forth—at the possible production through the burning of coal at KSC and at Vandenburg of electrical energy that you would use, and as the byproduct the production of hydrogen that you would use as a fuel. Please take a look at that.

Mr. BEGGS. All right, sir. We will.

Mr. FLIPPO. Thank you.

Mr. Dunn?

Mr. DUNN. Thank you, Mr. Chairman.

I do not have a question. I would like to express some concern, though, about the cutbacks in the aeronautical portion of the budget, particularly in the systems technology area. I look at the problems that face that industry, namely development of a commuter aircraft. I look at the areas that we are weak in in that industry in competition with other countries—that also being the commuter aircraft. I look at the consumer needs of this country as we go to airline deregulation—you come up with the same answer, commuter aircraft. Then as I look at the program, particularly the prop fan research—the subcommittee chairman, Mr. Glickman, and Mr. Shamansky and I went to Lewis Research Center—I cannot come to the same conclusion that you did that a program that has a potential of saving 15 or 20 percent in fuel for these instances I just mentioned is not a good use of funds.

While I am as big a supporter of the Shuttle program as anybody else on the committee, the vast amounts of money that are being put in there, to take some of it back out and put it into this aeronautical budget that I am talking about in terms of the crisis that this country faces, I think would be a better use of money. I would like that so stated for the record.

Mr. BEGGS. Yes, sir.

Mr. FLIPPO. Mr. Shamansky?

Mr. SHAMANSKY. Thank you, Mr. Chairman.

I am glad that my colleague, Congressman Dunn, just touched on that because I have to remind myself that this is the National Aeronautics and Space Administration. If the space programs gets over $5 billion out of $6.6 billion, there is certainly a lot more stress on space these days than on aeronautics.

Because I am very much interested in the whole matter of utilization of energy which gets me into the question of vehicles, look-

ing at the money provided for the Lewis Research Center, to say that you are not contemplating closing it as such, the 1981 actual budget was over $19 million, the 1982 estimate over $18, the current estimate $8.7 million, and the 1983 budget estimate is barely $6 million. In fact, it is being closed down not by attrition but by deep surgery.

I would like to have some comment. Why even pretend to carry this on? Why not just submit legislation to get out of the area of automotive or anything else like that? You are practically closing down the Lewis Research Center anyway.

Mr. BEGGS. Sir, I cannot track your numbers. Let me——

Mr. SHAMANSKY. I have here in your budget estimates, fiscal year, I turned to the tab marked "Space Applications"——

Mr. BEGGS. I understand now, sir.

Mr. SHAMANSKY [continuing]. "Distribution of Program Amount by Installation," and I am looking for Lewis Research. It is going to be one-third.

Mr. BEGGS. No, sir. My figures on Lewis Research Center are that in fiscal year 1982 we will be spending about $98.4 million in research and development and in fiscal year 1983 we will be spending about $87.7 million, a reduction of about $12 million. In total, the Lewis Research Center—that is, including the research and program management—in fiscal year 1982 we will be spending $209.5 million and in fiscal year 1983, $205.4 million, so the numbers——

Mr. SHAMANSKY. OK. I am misreading this page.

Mr. BEGGS. I think what you are referring to, sir—and that is the reason I was not following you——

Mr. SHAMANSKY. OK.

Mr. BEGGS [continuing]. Is with respect to the energy program and the applications program related to the Lewis Research Center. With respect to that energy program, the indication that we have from the Department of Energy, which is the only thing I have to plan with, is that the programs that we were conducting at the Lewis Research Center are being phased out.

Mr. SHAMANSKY. OK.

Mr. BEGGS. They will not be continued beyond fiscal year 1983. I had to plan on that basis and my planning numbers are so constructed.

Mr. SHAMANSKY. Are you contemplating submitting legislative changes to allow you to drop work in the electric and hybrid vehicle——

Mr. BEGGS. No, sir, I am not. I am only responding to what has been an initiative. I never had a specific budget for that activity. It was moneys that were put up by the DOE and transferred to NASA.

Mr. SHAMANSKY. OK.

Mr. BEGGS. In the case of Lewis, it amounted to, I think, at the peak something on the order of $100 million. Since it is down to virtually nothing in the DOE fiscal year 1983 submission, my plans are made on that basis. If that should change, my plans would change.

Mr. SHAMANSKY. In effect, if DOE gets out of that, Lewis is out of it.

Mr. BEGGS. That is correct. Yes, sir.

Mr. SHAMANSKY. OK. Next question, because I am also concerned with space applications, especially in the communications area: What evidence is there that the private sector can and will pick up the area vacated by NASA, especially when compared with what the foreign governments' efforts are in this area? I am thinking about even around Columbus, Ohio, which is where I am from, there are a lot of these dishes around town now with respect to businesses and public service agencies. What do you contemplate happening there? It has been a tremendous step forward for our country in terms of communications.

Mr. BEGGS. We are continuing the technology work in communications. In the new spectrum of the 30/20 gigahertz range, we are continuing to pursue that technology. Again, the policy is that we will develop the technology and then pass that technology on to the interested industry with the expectation that they will carry it into validation and hardware.

Now, with respect to the earlier communications work, clearly that technology has burgeoned into a fairly sizable industry and they are sustaining the ongoing work for new satellites as well as new applications of those satellites. With respect to the 30/20, we originally had an amount of money set aside to do the validation.

Mr. SHAMANSKY. How much was that, Mr. Beggs?

Mr. BEGGS. Close to $30 million, sir.

Mr. SHAMANSKY. What do you have now?

Mr. BEGGS. In the validation area, nothing.

Mr. SHAMANSKY. Who is going to validate it, the private sector?

Mr. BEGGS. We hope and we trust, the private sector.

Mr. SHAMANSKY. However, there is no assurance.

Mr. BEGGS. I have no assurance, but this particular one is a well-developed technology; plus it is a profitable area. There are any number of ongoing projects from COMSAT through the various and sundry data transfer companies which have been set up to utilize satellite technology and satellite operations because of the very rapidly growing communications market. The 30/20 gigahertz range opens an entire new spectrum which should be of immense economic benefit; therefore, I think that there is reason to believe that the industry would pick up on that.

Mr. SHAMANSKY. However, your budget has gone down to zero on that?

Mr. BEGGS. On the validation aspect, we still have a program of technology that is directed toward the critical elements of that particular frequency spectrum.

Mr. SHAMANSKY. Could you then describe very briefly what sort of ongoing research and development program you have in the communications area?

Mr. BEGGS. Yes, sir. In the communications and information systems area we intend, as I said earlier, to develop, test, and evaluate the technology for this new band, 30/20 gigahertz, and to then be capable of passing on what are the critical elements of that to the industry. We also intend to continue to work in the development of multibeam antennas for application to geosynchronous orbit to attempt to reduce the necessity for a lot of satellites. In other words,

we will put up larger stations with more directional antennas and so forth, to accommodate that technology.

High-speed switching systems which are necessary to pursue the technology to more productivity is another area including low-noise receivers, which are always essential when you are dealing with satellite communications; various types of new solid-state transmitters to improve both efficiency and size of those transmitters; and those classes of technologies which generally are things that are developing. They are the technologies that have been essential to the development of this particular business area.

Mr. SHAMANSKY. Mr. Chairman, has my time expired?

Mr. FLIPPO. Yes; if you have a final question, however, please proceed.

Mr. SHAMANSKY. No, no. That is all right, Mr. Chairman. I just wanted to make sure I heard the bell. Thank you.

Mr. FLIPPO. Thank you.

Mr. Lowery?

Mr. LOWERY. Thank you, Mr. Chairman.

Mr. Beggs, it is good to see you again in one of these hearings. I know we have previously held hearings on the budget in the overall Committee on Science and Technology, and NASA has fared better than some agencies and departments this round, maybe not as well as some of us would like to see.

I would like to concentrate my questioning on Centaur. It is a subject that I have an interest in. Aside from some constituency concerns, I have deep concerns about planetary exploration, about some of the philosophical questions of NASA continuing to retain a civilian identity when about half of its budget is now going—in fact, over half—to the Shuttle, and some of the cost-consciousness that I think all of us share as taxpayers, that we can get the most bang for our buck.

I would like to ask you several questions in three areas: one, the mission of Centaur from NASA's perspective, looking at the track record and the future potential of an IUS versus Centaur, and then just getting into the costs themselves.

If Galileo, if the mission utilized the IUS upper stage rather than the Centaur upper stage, will the orbiter and probe reach Jupiter as soon as it would have on Centaur, as planned in your first and fiscal 1982 budget?

Mr. BEGGS. No, sir. It will be about 2 years later.

Mr. LOWERY. A 2-year delay?

Mr. BEGGS. Yes, sir.

Mr. LOWERY. If launched on an IUS, will the Galileo orbiter still be able to perform the same number of orbits it would have performed had the mission been launched in a Centaur?

Mr. BEGGS. No, sir. There would be some reduction in the number of satellite encounters.

Mr. LOWERY. How would you describe the mission being amended, then, from what was initially proposed?

Mr. BEGGS. We believe that in spite of the problem with schedule, that is, late arrival of the mission to Jupiter, we will get 85 to 90 percent of the science and information that we had previously intended to get with the Centaur-launched——

Mr. LOWERY. That is with the reduced orbits as well?

Mr. BEGGS. With the reduced encounters, yes.

Andy, is that about right?

Mr. STOFAN. The percentage is a little high but that is about right.

Mr. BEGGS. Andy says my percentage is a little high.

Mr. LOWERY. What is more realistic?

Mr. BEGGS. Do you want to answer?

Mr. STOFAN. It is hard to give a percentage.

Mr. LOWERY. Maybe you could get back to me with more detail in terms of what we would lose compared to——

[The information follows:]

Estimating precisely the percentage of the overall science objectives which can be achieved by launching the Galileo mission via the Shuttle/Inertial Upper Stage in 1985 is very difficult and potentially misleading. In looking at the primary objectives, however, one can group the investigation into the following categories:

1. Probing the atmosphere of Jupiter,
2. Observations of the planet Jupiter,
3. Observations of the satellites of Jupiter by targeted encounters (less than 10,000 km), and non-targeted encounters (more than 10,000 km but less than 100,000 km), and
4. Investigations of the magnetosphere.

With regard to items 1, 2, and 4, it is estimated that there is greater than 90 percent probability of achieving 100 percent of the science objectives with the Shuttle/IUS launch.

With respect to item 3, the Shuttle/Inertial Upper Stage launch mode will allow for six targeted satellite encounters versus the originally planned eleven encounters.

Consequently, while it is difficult to give precisely the percentage of the overall science objectives which can be achieved by the Shuttle/Inertial Upper Stage launch mode versus launching Galileo via a Shuttle/Centaur, I believe there is a relatively high probability that 85–90 percent of the overall mission science objectives can be achieved with the IUS launch.

Mr. BEGGS. The probe will still be the same, Mr. Lowery. I think that point probably needs to be made. That was the important new thing we were going to do. As we described, the number of encounters will be reduced and that will mean we will have fewer observations over that period of time. If you would like, we will give you an estimate.

Mr. LOWERY. If you would, please. I am also curious as to what happens with all those folks at JPL during the added 2 years. Is there a cost consideration there?

Mr. BEGGS. There is a cost consideration because of the 2-year extension but as I said earlier in my testimony, it is our hope and our belief that before the 1985 time period we will have some new starts that will keep JPL occupied in some other things.

Mr. LOWERY. Let's move into the area of track record and future potential. I have trouble understanding why, after the difficulty experienced with IUS—about a $500 million increase in the development cost from what was projected and some years delay and slippage—NASA, having evaluated this over a year ago, is shifting back to IUS and risking a mission such as Galileo, as important as Galileo is, with IUS.

Mr. BEGGS. We had extensive discussions with the DOD, the Air Force, who are the executive agents for the development of IUS. As you described, there have been problems in the program in the past, cost growth, schedule slippages, and so forth. Everyone was concerned and we did discuss these problems with them. The Air Force had a strong position, backed by program reviews that they

were over all the remaining hurdles, that from here on out they were prepared to go into production with a vehicle that would perform as advertised.

In the course of that development and as a result of the fact that the number of missions that were going to be flown on IUS have been reduced, the cost per unit has increased significantly—it is now in the $50 to $60 million-per-stage category.

Mr. LOWERY. The last estimate I heard was about $68 million a bird.

Mr. BEGGS. Well, I will not quarrel with your numbers. The point is, though, that in getting any unit cost estimates, as you know you have to project a mission model and figure out how many you are going to buy. It could be anywhere from $50 to $70 million. I would not argue that. My current projection is still $50 to $60 million.

Mr. LOWERY. Therefore, I mean, are you convinced that the problems that have existed, that the uncertainties with the slippage, the cost growth are all resolved sufficiently to switch back NASA's decision to go with IUS?

Mr. BEGGS. Yes, sir, I am. I am convinced that they can produce the IUS and that it will fly as it is currently advertised. It will handle the missions. Its capability clearly will satisfy our requirements. I cannot argue that point. It does not have the future capability of the Centaur, which obviously is a much more capable——

Mr. LOWERY. You are anticipating my next question.

Mr. BEGGS. I knew you were going to ask that. [Laughter.]

The Centaur is a much more capable stage, it will handle a lot more payload. It is a lot more versatile. If I had my druthers and was able to project a sufficient demand for that, I would like to do it but I cannot.

Mr. LOWERY. Mr. Chairman, I know we are running low on time. Could I ask one more question that gets into the area of costs?

Mr. Beggs, could you give me a cost comparison between Centaur and IUS both in terms of developmental costs, the costs that we have sunk in it to date, as well as what we are looking at in terms of some future development costs, and the costs per bird not including those nonrecurring development costs?

Mr. BEGGS. I will have to get it for the record, Mr. Lowery, the exact costs on the IUS. My understanding is that $455 million has been expended through 1981 and runout costs are estimated to be around $680 million. The NASA part of that was on the order of $150 million or thereabouts. As I said, we are committed to buying five of the first nine of those. I will provide the current figures for the record because, as I said, my memory is $50 to $60 million per copy.

For the Centaur stage, we were projecting a development cost of about $230 million to make the changes and about $110 million to integrate it into the Shuttle. The production or unit costs were projected in the $30 million ballpark or about half of what the IUS is projected to be.

[The information follows:]

Mr. LOWERY. Well, if each bird is going to run about half the cost, what is the——

Mr. BEGGS. Yes, sir, but I only have two missions. That is my problem. If I had more missions, I would be in very good shape. I only have two missions and so I have to write off that $340 million of development.

Mr. LOWERY. Well, how about from DOD's standpoint, if it has double to triple the capacity——

Mr. BEGGS. If I could find DOD requirements for missions for the Centaur that need the additional capability, then clearly you can write off that $340 million fairly fast when you are only spending half as much per stage. However, we did not identify those mission requirements.

Mr. LOWERY. How much more in development costs is projected for IUS?

Mr. BEGGS. I really do not know and I am quite sure we do not have them here. That is Air Force information. I will get it for you, however.

Mr. LOWERY. OK.

Mr. Chairman, I thank you. I appreciate your indulgence.

Mr. FLIPPO. Thank you.

Mr. Beggs, I want to refer just briefly to this area of the concern expressed on the part of the committee and others about the militarization of NASA, to make sure that perhaps we are not using the wrong definitions. You have talked about maintaining a separate civilian space program but I think that it is obvious that the separate programs that we have within NASA are being done in large part for military reasons.

I think what we are interested in, I think we refer to civilian programs as those that are done for civilian reasons. I know that we are maintaining a separate civilian work force but the evidence of the budget—when we see cutbacks in programs, you make the statement that spacecraft development projects presently underway continue unchanged, Landsat and the space telescope are continuing—but the GRO and the ISPM, the VOIR and the Galileo-Jupiter orbiter and polar missions have been severely damaged.

As I look at the applications area, it seems that of all the activities that NASA is involved in, that the applications area could have some of the most tangible short-term payoffs for the country. It is hard to understand why this element of NASA's overall budget has been so drastically reduced in the 1983 budget. I note with interest that the 20-30 gigahertz experiment has reduced funding. I am concerned about potential elimination of receipt of transmissions from the Pioneer spacecraft.

I know these are considerations that concern you as well, and the members of this committee appreciate very much your obvious and forthright response to provide a full explanation of the questions with which you are presented. We look forward to working with you in resolving these conflicts and I am sure they will occupy us for some time into the future.

Thank you so much for being with us today.

Mr. BEGGS. Thank you, Mr. Chairman.

Mr. FLIPPO. The subcommittee will meet again tomorrow morning in 2325 at 9 a.m.

[Whereupon, the subcommittee recessed, to reconvene at 9 a.m., on Wednesday, February 10, 1982 in room 2325, Rayburn House Office Building.]

1983 NASA AUTHORIZATION

WEDNESDAY, FEBRUARY 10, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to call, at 9 a.m., in room 2325, Rayburn House Office Building, Hon. Ronnie Flippo (chairman of the subcommittee), presiding.

Mr. FLIPPO. Good morning. The subcommittee will come to order.

This morning the Subcommittee on Space Science and Applications continues hearings on the NASA fiscal year 1983 budget request. We will focus on the budget request for space transportation systems including the Space Shuttle, space operations, and expendable launch vehicles.

We certainly want to congratulate the NASA industry team for the first two flights of the Space Shuttle. In a time of much bad news, these two flights have raised the American spirit and given our Nation renewed pride in our unexcelled engineering expertise.

We look forward to the next flight presently scheduled for March 22. With the completion of the series of flight tests in fiscal year 1982 and beginning of operational flights hopefully in fiscal year 1983, we must give increasing management attention to achieving more efficient operations and increased service to build the flight rate and reduce the turnaround time.

Our witnesses will be Maj. Gen. James A. Abrahamson, Associate Administrator for the Office of Space Transportation Systems and Dr. Stanley I. Weiss, Associate Administrator, Office of Space Transportation Operations.

I want to welcome you, General Abrahamson, making your first appearance before our subcommittee. We are very pleased to have you. In light of the concerns raised yesterday regarding NASA involvement in military technology, I want to assure you that we welcome you and that any remarks concerning militarization is not directed toward you in any way.

You bring a tremendous amount of experience and talent to the program. We are indeed pleased with your work, and the broadly based complimentary remarks from other senior officials throughout the program at various centers and contractors join us in that.

Again, welcome to the subcommittee. Before you start, I would like to acknowledge Mike Weeks and congratulate him for leading the Shuttle program forward through the second flight.

Since the two programs are very closely related we would like to hear from both our witnesses before going to questions this morn-

ing. I am delighted to see the ranking minority member of the full committee, Mr. Winn, who is also a member of this subcommittee.

Mr. Winn?

Mr. WINN. Thank you, Mr. Chairman. I have no comment. Thank you.

Mr. FLIPPO. Thank you. Please proceed as you deem appropriate.

STATEMENTS OF MAJ. GEN. JAMES A. ABRAHAMSON, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE TRANSPORTATION SYSTEMS, NASA; DR. STANLEY I. WEISS, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE TRANSPORTATION OPERATIONS, NASA; AND L. MICHAEL WEEKS, DEPUTY ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE TRANSPORTATION SYSTEMS, NASA

General ABRAHAMSON. Thank you, Mr. Chairman.

Since this is my first formal testimony before your subcommittee, I would like to say for the record what a privilege it is for a military man to join NASA and to be part of the very illustrious team that NASA represents. I have been made to feel most welcome. In addition, and equally gratifying, I have been made to feel welcome by you, the members of your subcommittee, and your staff. Therefore, it is a privilege for me to be able to testify before this subcommittee which has such a long record of leadership for our nation's space effort. Thank you.

I would like to present my full statement for the record and give a short briefing. It is my hope that it will provide a framework for your questions as we proceed.

Mr. FLIPPO. Very good.

We are going to have a slide show now?

General ABRAHAMSON. Obviously, figure 1 despicts the NASA team's second flight, STS–2. It was my first opportunity to see the Space Shuttle team in action, and I was most impressed.

As I go through this presentation, figure 2, I will briefly touch on the program's progress, which I believe represents a tribute to the managers and the people who have been working this program, both within NASA and contractors for a very long period of time.

[Commencement of slide presentation.]

General ABRAHAMSON. We will look at the delivery schedule and our plans for flights in 1982, our initiatives and the priorities we have laid out for the budget itself, and then a very brief review of the structure of the budget.

I feel everyone is familiar with these accomplishments, figure 3, so I won't spend time here. However, I must note that STS–1 was the first spacecraft that was manned on its maiden flight. STS–2 of course, was the first reuse of an entire spacecraft. We look forward to the Columbia, and our future orbiters being reused for a very long period of time. We believe these two successful flights show the promise of the Shuttle in a very effective way. Our next flight, STS–3 is scheduled internally for March 22; and we are presently ahead of our internal planning schedule. We are quite confident about that date. We did move from the orbiter processing facility (OPF) into the vehicle assembly building (VAB) on February 3, and we are not in an integrated vehicle test.

Here (figure 4) was a proud moment as Joe Engle and Dick Truly brought STS-2 back to Edwards Air Force Base. In this particular flight, we gained a great deal of confidence in the orbiter's thermal protection system—the tiles. If you go back in history that was one of the subsystems that people were particularly concerned about. The vehicle sustained only about a third of the tile damage on STS-2 that we experienced on STS-1.

Let's look briefly at several items where we are making substantial progress, figure 5, on the main engine. In terms of rated power level, the 100 percent thrust rating on the main engine, the certification was completed some time ago. We are now using two engines in a four-cycle certification program to upgrade the engines to 109 percent or the full power level (FPL) rating. Just yesterday, we completed our first FPL certification cycle of 5,000 seconds. We will continue for three more cycles to complete full power level certification by early 1983. The first time we plan to exceed 100 percent will be for the STS-5 launch which is scheduled in January 1983.

We have an experienced launch and operating team in place. They are getting better and improving the procedures with each launch. Another important system element is the mobile launch platform, number two, which will be needed as we go ahead in the future to higher flight rates. The mobile launch platform (MLP)-2 will be ready in September in time to begin stacking the solid rocket motors for STS-6. With that delivery, we will be able to do stacking for two systems. Funding for the mobile launch platform-3 is not scheduled to be included in CofF funding request until fiscal year 1984. However, I have advanced the schedule slightly by putting some R. & D. money into long lead efforts, approximately $1 million in fiscal year 1982 and another $4 million in fiscal year 1983. This is to ensure we can make an early start in fiscal year 1983 as is possible. The DOD secure firing room will also be ready late in 1982 which is funded by DOD, but will be part of our integrated launch setup at KSC.

Turning to the solid rocket booster (SRB) status (figure 6), we have six of the eight segments already delivered at KSC for STS-4. All of the other mechanical elements, frustrum and aft skirt assemblies for both STS-4 and STS-5 are in work at KSC. We expect the SRB elements for STS-5 to have an adequate delivery margin to support those flights. We will complete the high performance motor test firing in 1983. That test will be important for the STS-8 launch because we need as much payload capability as we can get at that point. We did have damage to the aft skirt of the SRB as it entered the water on both STS-1 and STS-2. We now have designed a modification which supports the critical structure rings with added vertical stiffeners. We hope that will be successful in STS-3 and solve that particular problem.

The STS-4 external tank (et) is already hanging in one of the bays of the vehicle assembly building undergoing final close out items. The first lightweight tank is already under construction and test. This version of the tank will be required for STS-6. I understand that this has been a schedule concern in the past. It is now coming along very well. We are expecting it to be delivered to KSC by September 1982.

We have allocated money in this budget for production readiness. These are automation items and other items needed to increase production and reduce costs on the external tank. It will be spent primarily at Michoud. You will see some of those when you visit Michoud. Additional money is also included for producibility improvements. There is a substantial amount of money, $18.5 million, allocated in fiscal year 1983 for tank producibility which is the key to achieving our flight rate of 24 per year in the future.

This is a picture tank assembly taken in January, figure 7. This is the STS–4 tank which is now at KSC and it also shows the tank for STS–5 in construction. This picture of the main engine final assembly was taken last week at Rocketdyne, figure 8. It shows all three of the Challenger's main engines. They are ahead of schedule at this point. This one, in the back of the room will be ready for delivery from Rocketdyne in approximately 2 weeks. It will go to the NSTL firing facilities to undergo about a month of acceptance testing. Then, it and the engines will be mated to Orbiter 099 at KSC.

Here is the orbiter delivery schedule, figure 9. This was an area of concern as the fiscal year 1983 budget was being put together. Of course, there were tradeoffs considered in terms of maintaining this schedule. I think the history of the program and my experience in many programs show that the most cost-effective schedule is one that is planned and remains stable. If you accelerate, it usually costs more, unless it is just a minor item that you bring forward. Or, if you slip the schedule, it usually costs substantially more. What we have done is to make a major effort in 1982 and 1983 to allocate our moneys to maintain the schedule. We will, using a constant work force philosophy, work to the schedule shown. Right now, the scheduled delivery for Orbiter 099 is June 1982, which will be tight. There may be a problem of a couple of weeks; however we are still hoping for a June 1982 delivery.

STS–6 will be flown on Orbiter 099 in January 1983. After delivery and mating with the engines, there will be some modifications and some closeout actions made at KSC. We think this will be the most cost-effective approach. There is margin in the Orbiter delivery schedule to maintain that launch. Columbia, of course, will be used for both STS–3 and STS–4. After STS–4, we have about 29 working days of modifications. We have reduced these days to the very minimum level possible because we think they can be more effectively done at Palmdale along with other previously planned modifications. These modifications to Columbia will include adding two more seats, because the fifth flight will be the first where we have four crewmen, and installing a harness to connect to our first operational payload.

Columbia will complete that flight, and then be shipped to Palmdale for approximately 6 months of modifications. Here is where we really take the vehicle out of its present R. & D. configuration with its flight test harnesses and data gathering instrumentation as well as deactivate the ejection seats and put in heads-up display. These modifications will continue to about June 1983. Orbiter 103 has some elements behind schedule, but it is not seriously behind schedule at this time. We are quite confident of a delivery in the presently planned time frame.

A key point is that while we have allocated money in fiscal year 1982 for Orbiter 104, it will be tough to maintain the schedule within that allocation. However, that is our objective.

I believe you probably saw the OV–103 crew module (figure 10) out at Downey on your recent visit. Here are our remaining test flights, figure 11. STS–3 is to be a 7-day flight, while many of our operational flights will be for a shorter time frame.

We are planning both STS–3 and STS–4 landings to be made at Edwards Air Force Base. This is a conservative approach toward assuring ourselves that we get a conservative approach to crosswind landings. Although the Orbiter is limited, at this point, to a 20-knot crosswind, we would not like to have our first 20-knot crosswind landing be on a runway at KSC.

So, we are trying to get a 15 knot or less crosswind landing at Edwards to see how the vehicle operates. On STS–3, we will be primarily looking at long duration thermal tests and filling out our test matrix in aerodynamic and in operational activity areas.

The OSS–1 pallet is, of course, in the vehicle at this time. Last week I was at Lockheed and I saw the DOD payload for STS–4; it is well ahead of schedule. We also visited Hughes, looking at the Ku-band radar, which has been delayed. While we were there, we saw both of the STS–5 communications satellites to be put in orbit by STS–5. We are also considering a potential EVA demonstration on STS–5.

Figure 12 indicates a series of initiatives we have been working on. Yesterday, you commented on one of the management studies that were made and asked how it was being implemented across the agency. In 1979 I participated in one of the studies on the management of the Space Transportation System. There may be a lesson, perhaps for everybody. "You better be careful with free advice, because someday you might have to live with it." One of the items I noted then was that reserves should be distributed down into the program at the proper level. We have now gone through a reallocation process for our fiscal year 1982 budget and, at the same time examined how our expenditures that flow into fiscal year 1983. As part of that process, I am abiding by my own recommendations. We have allocated a substantial amount—in fact, most of our program reserves for fiscal year 1982 have been sent down to the centers, and in some cases, down to the program elements. So, they can plan for stability, but also know what they must do to live within their allocation. Each center director is pleased with this procedure and I think we will have more stable and efficient programs—which is our objective.

All of us are making a very strong effort to translate from the R. & D. program that now appears to be promising, into an effective the operations phase. That is where the real payoff is on this vehicle. Obviously, we are beyond this. Fundamentally, we must have a safe and error-free operation. When you consider the complexity of the vehicle and the thousands and thousands of operations, this is a very difficult goal. But, everybody is expending a major effort to achieve it.

Cost incentive contracting is another tool. Mr. Beggs has made it a matter of policy that we move to incentive contracting wherever possible to bring costs down. We have in negotiation at Marshall

CENTAUR/IUS ALL YEAR NASA COST COMPARISON

		LONG CENTAUR (2) Long Centaur for Planetary (3) IUS's for TDRS	△	FY 1983 BUDGET (2) Two-Stage IUS for Planetary (3) IUS for TDRS
Upper Stage Development		316	-152	164[a]
(Does not include SSUS)	IUS	86		148[b]
	Centaur	230		16
Upper Stage Operations		368	- 11	357
(Does not include SSUS)	IUS	168		354
	Centaur	175-200		3
JSC/KSC Modifications		110	-110	-

The total NASA upper stage development and procurement cost which include IUS and Centaur using the long Centaur for Galileo and ISPM would have been about $684 million. In addition, we would have required $110 million for orbiter and KSC modifications for a total of about $794 million. The two-stage IUS option required about $521 million. Therefore, from an upper stage aspect, the Centaur would cost about $273 million more than the IUS. However, the Galileo project will cost about $170 million more using the IUS and the ISPM requires about $40 million more for a kick stage when the IUS is used. On that basis, the net difference would be on the order of $60 to $65 million (273-170-40=63).

		CENTAUR	IUS
Sunk Costs end of FY 1981	Development	16	66 [c]
	Operations	3	48
Cost Per Vehicle (hardware cost)		35-40[d]	55 [e]

a. Does not include provision for continuation of RL-10 technology.
b. Material previously provided ($650 million to $700 million) included both NASA and Air Force IUS full-scale development costs. It included delivery of 8½ two-stage vehicles and one set of airborne support equipment. It also included support and services for two launches.
c. Material previously provided ($550 million to $575 million) included both NASA and Air Force sunk costs.
d. Dependent on production size.
e. Follow-on production of four vehicles.

our first transfer of a cost, plus award fee contract into a cost plus incentive fee contract. This is for the external tank. We have received our first proposal in terms of an incentive fee arrangement for the next phase of the solid rocket motors. We are moving in that direction and pushing very hard.

I found there are also real savings to be made with manufacturing modernization in the F-16. This program has also been planned around these kinds of efforts. You will see examples of real modernization activities of Michoud. I know your staff is familiar with some of these efforts. We will be trying to accelerate our program and to put even more emphasis on this in the future. The productivity improvements which Mr. Beggs mentioned yesterday, are being undertaken across-the-agency to look at ways to implement an improvement program that will make our dollars go further. This program will apply them not only to our own internal government operations and to our contractors, as well. We kicked that off. I have the headquarters responsibility to coalesce our activities across the agency in this area, because much of it is directed at the STS. But we are trying to go beyond the Space Shuttle area. We have assigned this responsibility as a field level activity to Marshall and they are moving out very effectively. They have assigned one of their best people to the job, Dr. Jim Kingsbury.

Monday we started with an initial seminar to develop a plan across the agency for the overall program. These initiatives are either underway, being re-emphasized, or are completely new efforts. One of our productivity initiatives that has been underway at Marshall, figure 13, is in developing new ways of spraying on ablators with robotics. We expect both weight and cost savings from these programs.

These goals became the priority basis for our budget, figure 14. I think your understanding of the way we are approach the budget is critical. Our first priority must be to conduct a safe and successful launch each time. If that requires a special or unplanned expenditure or development of an improvement, we will not hesitate.

However, right after that, is our second priority to maintain this operational schedule. We are now committed to a launch rate, building up to 24 flights per year. We intend to make that and are allocating our resources to insure that we can. I have moved the completion of R.D.T. & E. to a lower priority. There may be some less important elements of development that will drag out for a period of time. This does not mean we are leaving out or delaying fundamental parts of the program, but we will allocate resources to higher priority operational activities first. We must also keep the reduction of operational costs as a critical goal.

Finally, we have to somehow achieve a change in the way people think about developing satellites, putting them into orbit and the use of space payloads. I believe there are a series of initiatives to be taken, to change our basic cultural approach to the development of payloads for space. This is where the STS will really get payback. We shouldn't think of the STS Shuttle just as a truck. But, rather as a tool with some very important advantages that have never been available to us before.

If we use those new characteristics correctly, with imagination and creativity, in the whole space effort, the way we conduct scien-

tific experiments, the way commercial enterprises exploit space, and of course, the way the Department of Defense uses space to enhance our security, it could all be done more efficiently and more cost-effectively. These are the program priorities we have applied in our budgeting process.

I will make a few comments the overall budget summary. Figure 15 illustrates the overall budget framework. I would like to mention a couple of points about it. First, there is no more development in fiscal year 1983. Actually, there are dollars that could be classified either as development or as production. So, this is an arbitrary change; but, one that has been planned and previously explained. The remaining development is distributed in several different places in the budget and represents such things as the engine life certification—something that will go on for a very, very long period of time We thought it was appropriate to change that into a production line item. There are several similar items—some improvements we will make based on the recommendations of the safety advisory panel. As we evaluate improvements and expend those moneys, it will be similar to the production improvements we fund in the production line items in the Department of Defense budget. I believe, we are consistent with the will of Congress in this accounting change.

A similar change is in the DTMS account because we are now changing to an Engineering Technical Base Management approach. It is a concept which is different. Under the Engineering and Technical base approach, we will be funding only the core of facility and support contractors who are required for our manned space flight capability in the future.

This change is in consonance with a letter sent to your subcommittee in 1980. So, we are carrying through with an agreed plan, whereby, the programs will fund certain peculiar tasks that were previously DTMS funded. As an example, many peculiar tasks will now be funded in STS, some in STS operations.

Other DTMS funded efforts will now be funded in different places. So, it is not that we have dramatically reduced the overall funding level, previously in DTMS, that number, although we are working to do that. Instead, we have changed the concept, and we believe this will be an important tool in bringing down the costs of operations as we go along.

As Mr. Beggs mentioned yesterday, we have changed the reporting chain and responsibility for NASA's institutional base. The Associate Administrator for Space Transportation Systems now has the institutional responsibility for these four centers—JSC, MSFC, KSC, and NSTL. This is my R. & P.M. budget for those centers (fig. 16). You will notice a slight increase at each center which reflects an increase in costs of pay raises and operation of the installation, but that increase is very slight.

Along with that institutional responsibility comes the responsibility to approve and to work with the NASA Office of Facilities to coordinate our C of F funds and insure that they are consistent with the programmatic objectives. So, here is a summary of our C of F request, figure 17. Most of that is being spent at Michoud to bring down the costs of producing the external tanks. The others will be addressed later. I will be glad to answer any questions you

may have now; but General McGarvey will testify separately on these items, as well.

In summary, figure 18, we are beginning the operational phase of the program with STS–5. There are still some developments that will follow. Nonetheless, we feel comfortable with undertaking the real business of the Space Shuttle. We are maintaining an operational plan that includes a total of 32 flights through fiscal year 1983.

Obviously, throughout that time frame, we will be looking ahead and to see if the demand is higher or lower. It will be an important part of our planning to see how changes in demand may affect future budgets. However, we are now aiming for this 24-flights-per-year capability by 1988. This is a solid planning base, something we can use consistently across the program.

Mr. FLIPPO. May I interrupt. How many orbiters will you have to have in order to maintain that 24-flight schedule in 1988?

General ABRAHAMSON. If everything went perfect, which we don't actually expect, then four orbiters will support the existing manifest. But, that is not a practical way to plan a program. A more proper way to plan is to have some excess capability, as Mr. Beggs mentioned yesterday.

We believe that to support this higher flight rate prudence would dictate buying at least a fifth orbiter. If the level went higher than that, it could indicate that additional orbiters could be required. As I mentioned, we have certain performance capability improvements in our plan as well. An important one is a filament wound case. With your approval, we would like to begin development now to support a first flight in 1985. That is the first flight out of Vandenberg Air Force Base, which might require higher performance. This is a tough schedule to maintain.

These two items are tied, as I indicated, to the TDRSS flight in January. We are also proceeding very well for our manned maneuvering unit development. That is quite important to an initiative that has been discussed with your committee, but not yet been approved—the Solar Maximum Repair Mission. At Vandenberg, the Air Force is optimistic for an October 1985 launch for that operation. The Air Force has a reprograming request for Vandenberg in Congress, which is really an adjustment of the money in fiscal year 1983 and fiscal year 1982. However, they believe the date can be maintained.

We are looking for our second launch pad at KSC in 1986. So, this national system will then really have a redundant capability for the last half of the decade.

With that, sir, if there are no further questions, I would like to turn it over to you or Dr. Weiss.

[The prepared statement, plus answers to questions asked of General Abrahamson, follow:]

STATEMENT

OF

MAJOR GENERAL JAMES A. ABRAHAMSON

ASSOCIATE ADMINISTRATOR FOR

SPACE TRANSPORTATION SYSTEMS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Subcommittee:

Thank you for this opportunity to present NASA's Space Transportation Systems (STS) budget request for FY 1983. The responsibilities of the Office of Space Transportation Systems includes the Space Shuttle Programs - Orbiter, Main Engine, Systems Engineering and Integration, and Ground Systems and Flight Test; as well as the Upper Stages, External Tanks (ET), and the Solid Rocket Booster (SRB); and Advanced Programs for the study of future space equipment and transportation systems.

Additionally, under a recent NASA reorganization this office is now charged with planning and approval of Institutional Management at the Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Johnson Space Center (JSC) and the National Space Technology Laboratories (NSTL).

I would like to use this occasion to express my pleasure at being assigned to NASA as the Associate Administrator for Space Transportation Systems. It is an honor to be able to work with such a talented and dedicated organization. I also look forward to working with this subcommittee which has given such strong support to our Nation's space programs.

The goal of Space Transportation Systems is to provide an effective, efficient and reliable transportation system. The key to this system is the Space Shuttle, conceived in the late 1960's and given the Presidential go-ahead January 5, 1972. After many years of development on this complex vehicle, this past year we witnessed the first two orbital flight tests of the Space Shuttle.

Both flights were highly successful in more ways than just meeting flight objectives. I feel, Mr. Chairman, these successes have given not only those of us directly involved in the program, but the Nation as a whole, an overwhelming sense of national pride. From an engineering viewpoint we could hardly have done much better.

Columbia, flying the first Space Shuttle mission as STS-1, was launched April 12, 1981 from the Kennedy Space Center. Overall system performance during ascent was excellent, with all propulsion systems operating flawlessly. All subsystems performed according to specifications during on-orbit operations, reentry and landing. Astronaut reports on the vehicle were very complimentary with special emphasis on the orbiter's handling characteristics.

With the landing at Edwards Air Force Base (EAFB) on April 14, 1981, all major flight objectives were met successfully.

The number of problems encountered during the STS-1 mission were less than expected for a system of this complexity. The most significant problem was a reflective shock (overpressure wave) at SRB ignition. The SRB ignition overpressure produced higher than predicted structural loading in the orbiter which led to test and installation of an overpressure suppression system for the second launch.

After a launch scrub on November 4, STS-2 was launched November 12, 1981. Overall systems performance during ascent was, again, excellent and quite similar to STS-1. Orbiter subsystem performance on-orbit was, on the whole, very good. However, a fuel cell problem was encountered during the first day. Although we had reason to believe Columbia could well have flown the full five-day mission on the remaining two fuel cells, we elected to follow the conservatively written flight rules and implement a minimum (54-hour) mission. Even with this preplanned shorter mission, nearly all the major STS-2 mission objectives were achieved, including test of the Canadian developed Remote Manipulator System (RMS), and demonstration of orbiter capability to support attached payloads. Following an accelerated crew activity timeline, 90% of the STS-2 high priority flight objectives were achieved, and, 70% of the payload data was acquired. The astronauts again noted the excellent flying capabilities and achieved a nominal reentry and landing at EAFB on November 14, 1981. The completion of the STS-2 mission demonstrated orbiter reusability, the importance of the crew in contingency situations, and the excellent coordinated reaction of the flight crew and mission controllers under flight conditions.

The Orbiter Thermal Protection System (TPS) damage was significantly reduced from that encountered on STS-1. SRB ignition overpressure was about 25% of that measured on STS-1 and structural loads were well within design limits, indicating that pad modifications had solved the overpressure problem. The fuel cell problem has since been determined to be an isolated case of contamination and is not generic to the design itself. These and other minor problems are typical of a flight test program. Thus, these first two flights demonstrated the Space Shuttle as a viable new mode of space transportation.
The Space Shuttle Columbia is scheduled for launch next month on its third orbital flight test as STS-3,

a seven day mission. Carrying the OSS-1 science payload, STS-3 will also expand on tests done on previous STS flights but under more demanding conditions. Additionally, the long duration mission will permit a significant thermal exposure test to be conducted to determine the ability of the orbiter to maintain structural and systems temperatures within acceptable thermal - hot and cold - limits during prolonged attitude hold periods of up to eighty hours. STS-4, the final orbital flight test, will be flown in July.

The success of the first two flights has created a very positive attitude, leading us to concentrate even harder on ways in which we can reduce program costs and improve operations. To achieve these goals we will continue to view this as a total national space effort led by a NASA/DOD/industry team, aware of the nation's civil and national security needs. I am sure we will earn your and your colleagues' continued support in bringing what can be a powerful tool for the future --- The Space Shuttle --- on-line and into service. The first steps have been taken.

Mr. Chairman, we recognize that many of the economic woes of our country stem in part from decreasing productivity, and we are studying efforts to reduce this trend. As a first step we have established an agency-wide productivity improvement program to improve and demonstrate productivity improvement methods, procedures, quality, motivation -- every aspect of our business. The MSFC has been named to lead a sixty day study which I fully expect will provide bold ideas and practical initiatives. The program kickoff symposium, held February 8 at MSFC, was attended by teams from each NASA center and industry representatives.

In addition, NASA in coordination with the Aerospace Industries Association and the National Security Industrial Association is sponsoring a special product assurance symposium and a series of workshops to look at assurance techniques to support increased productivity. This activity is scheduled for early May, 1982.

On a related aspect, we are continuing to support the President's Office of Science and Technology Policy Study which deals with such questions as management of the operational Space Shuttle and how long we should continue use of expendable launch vehicles. This study is expected to be completed this summer.

FY 1982 Operating Plan

Before I address the FY 1983 funding request, I would like to comment on the FY 1982 operating plan which reflects a decrease of $31 million in the Space Shuttle below the amounts requested for FY 1982. This is a net adjustment, comprised of a reduction of $36 million and the inclusion of a $5 million reprogramming from Space Flight Operations to Space Shuttle for the proposed initiation of development on the filament wound case for performance augmentation. The $36 million reduction results from the allocation to the Space Shuttle of the general reduction in funding pursuant to Section 501 (41) of the HUD-Independent Agencies Appropriations Act. Within Space Shuttle program funding, the reduction was made to Changes and System Upgrading, thereby reducing the amount in this account from $300 million to $264 million. Subsequently, the $264 million in Changes and System Upgrading has been allocated to fund the increased requirements of $158 million and $106 million we now recognize in both the DDT&E and the Production phases, respectively.

In Space Shuttle DDT&E, the three principal areas requiring additional funding are: the orbiter, to which $50 million has been applied, to provide for additional engineering requirements at Rockwell for Orbiter development and systems engineering and at JSC to support continued development of flight software, the Manned Maneuvering Unit, the activities supporting the proposed spacecraft retrieval/repair demonstration using the Solar Maximum Spacecraft, and the space suit; the External Tank, increased by $31 million, to cover delivery schedule adjustments on the STS-3 and STS-4 flight tanks and increased effort on tank producibility and production readiness; and, for launch support activities at KSC, $61 million, to cover the increased costs of supporting the Shuttle launch processing.

The remaining $106 million of Changes and Systems Upgrading funding is being applied to Shuttle Production requirements, principally in the areas of the Orbiter, Main Engine and Spares and Equipment. The increase in the Orbiter program element funding is $23 million, in part to implement changes authorized to improve the performance of subsystems such as the reaction control system, fuel cells, the TPS and for the modifications which will be made to Columbia following STS-4. The Main Engine requirements have increased $39 million as a consequence of the series of engine test failures last summer while the full power level engine was undergoing initial testing.

Design changes have had to be made and implemented and production engine delivery schedules significantly revised to assure that the full power level development and certification program may proceed without impact to the availability of flight engines for OV-099. Spares and Equipment requirements have increased $38 million. This increase is primarily due to revised assessments for earlier deliveries of orbiter spares and the higher than estimated procurement costs for small quantities of items. Procurement costs for spacesuits have also grown substantially from previous estimates.

The development of the Solar Electric Propulsion System (SEPS) which we have had under study to support solar system exploration missions has been deferred and a proposal to reprogram $3 million of FY 1981 SEPS appropriations for use in space platform studies has been submitted.

The FY 1982 Operating Plan reflects a major change with regard to Upper Stages to be used with the Space Shuttle. As you may recall, NASA progress reviews in late 1980 of the NASA-unique three stage version of the IUS led to the conclusion there was a very low probability this upper stage could meet the Agency's requirements. Therefore, we initiated efforts to adapt Centaur for use as an STS Upper Stage for Planetary missions. During the FY 1983 Budget Planning, the decision was made to terminate the Centaur/STS development activities in favor of flying the Galileo mission on a non-optimum trajectory using the two-stage IUS and a kick stage. The European Space Agency International Solar Polar (ISPM) spacecraft will also be flown on a two-stage IUS with a kick stage. We are continuing studies of cryogenic upper stages, such as Centaur, for meeting future mission requirements. The FY 1982 requirement for Upper Stage development has as a consequence of the above decision decreased from $75.0 million to $23.2 million.

FY 1983 Budget Request

With respect to the FY 1983 Budget Request, the total budget authority requested for Space Transportation Systems in the Research and Development account is $3,467.8 million. In my testimony today, I will be addressing the elements within Space Transportation Systems for which I am responsible; Dr. Stanley I. Weiss, Associate Administrator for STS Operations, will, in turn, address the other elements of the STS Program: STS Operations, Spacelab, Expendable Launch

Vehicles, and STS Operations Capability Development--excluding Upper Stages Development.

Within the $3,467.8 million overall request, an amount of $1,844.3 million is requested for the Space Shuttle and for the Space Flight Operations activities concerned with Advanced Programs, Upper Stages Development, and the Engineering and Technical Base.

SPACE SHUTTLE

The Space Shuttle request is $1,718.0 million in FY 1983. These funds will provide for the continuation of Shuttle Production, for the development of the SRB filament wound case to augment the Shuttle's performance, and for the Changes and Systems Upgrading which we recognize are needed to improve the ground and flight systems. No funding is being requested for the Design, Development, Test, and Evaluation (DDT&E) Program in FY 1983 based on the completion of the OFT missions this year. There will be some residual development activities which will be pursued in FY 1983 and subsequent years; these are primarily concerned with the analysis of the data gathered during the OFT and initial operational missions, with continuing effort to improve the External Tank's producibility and production readiness efforts, and with the Main Engine's full power level certification and life demonstration testing.

Production

For the Orbiters we are requesting $933.5 million. The Space Shuttle Production Program is based on a national fleet of four orbiters. They are the Columbia (102), Challenger (099), Discovery (103) and Atlantis (104). The FY 1983 budget request will support production on Orbiters 103 and 104, and modifications to Orbiter 102.

The Challenger, used in the Design, Development, Test and Evaluation program for structural testing, is being modified to an operational vehicle. The modification is nearing completion at the Palmdale Final Assembly Plant and is scheduled to be delivered mid 1982. No major problems have been encountered during integrated testing and we are predicting delivery this summer. Challenger's first flight is scheduled for January 1983.

Substantial progress has been made in production of Discovery. By the end of 1982 major elements are planned to have been delivered. Initial and final systems installations, factory testing and checkout

will also have been completed. Discovery is scheduled for delivery in the fall of 1983.

The pace is picking up on the schedule for Atlantis. Assembly has started on the aft fuselage bulkhead, and hardware for other major elements is being manufactured. Deliveries of these major elements begin in late FY 1983 with arrival of the mid-fuselage at Palmdale. Planned delivery date of Atlantis is in late 1984.

Another major activity being funded in Shuttle Production is the modification of the Columbia to an operational flight vehicle. Initial modifications will be made at KSC prior to the STS-5 flight. Following this flight, Columbia will be returned to Palmdale for major modifications prior to being placed in operational use.

As the Congress requested, we are also investigating a fleet buy for our planned additional orbiters. It is believed that we might be able to achieve significant cost savings if we could buy the planned orbiters as a package rather than year by year. Also, a fleet buy would remove any doubts of potential users as to the long term availability of orbiters for meeting future flight rates.

For the Space Shuttle Main Engine (SSME), we are requesting $262 million in FY 1983. The SSME is the most efficient, high pressure liquid hydrogen/liquid oxygen rocket engine ever built. Unlike most previous engines, which had fixed power settings, the SSME is designed to be throttled from 65% to 109% of rated power during flight and is designed for reuse for up to 55 flights.

We are currently working toward development and certification of the Main Engine at full power level -- 109% of the thrust levels of the engines used on Columbia. The power increase will permit increased payload capacity and improved safety.

In the FPL development program we experienced two significant design deficiencies during ground testing last year, resulting in major damage to three development engines. The problems, main injector lox post cracking and fuel preburner injector element cracking, were unique to the FPL operations and design fixes have been established and are now being tested. The FPL certification testing is scheduled for completion in early 1983.

In Spares and Equipment, our FY 1983 budget request of $323 million is required for the initial lay-in of replacement spares for Shuttle components, tooling requirements to achieve higher production rates of ET's and SRB's and procurement of orbiter flight spares and crew equipment.

Initial spares include primarily line replaceable units, or those items for which the optimum maintenance is removal and replacement. These are considered an investment in assuring flight rates and processing times required for operational missions.

ET producibility efforts will continue in FY 1983. Our goal is to reduce future ET costs by identifying producibility improvements in assembly and manufacturing operations. Our production capacity now stands at 10 to 12 tanks per year with plans to increase the production rate to 24 per year by 1987. Clearly, we must make the transition from a development program to on-line production status as soon as possible. This transition offers us a clear target for productivity enhancements aimed at reducing the time and cost of building the tanks. Areas currently under scrutiny include improved welding techniques, automated inspection systems and alternate insulation foam materials. However, it is not just labor and techniques that contribute to increasing productivity; management and operations control methods also are being analyzed, including hardware flow to identify choke points, refinement of work standards, inventory control, labor reporting and discrepancy processing systems. Solid Rocket Booster and other production and management areas also are under the same type of analysis.

In FY 1983, the second test firing and verification of the Solid Rocket Booster's high performance motor (HPM) will be completed to support a summer 1983 launch. The HPM design involves minor changes to the thrust/time profile, throat diameter, and nozzle expansion ratio to provide a payload increase of 2000 lbs. Development firing is planned for the summer of 1982 and qualification firing in early 1983.

In Production Launch and Landing, the thrust of FY 1983's funding request of $67.0 million will be to design, install, checkout and validate the second line of processing facilities, including the SRB segment processing and storage facility, the second launch pad and the DOD secure third firing room. The SRB motor facility construction, to be completed in FY 1984, will support receiving, inspecting, rotating, testing and storing of segments, including aft segment buildup

prior to stacking on the mobile platform in a high bay of the vehicle assembly building (VAB). To support the operational readiness date of the second launch pad in FY 1986, intensive efforts have begun to initiate plans and long-lead procurements for ground support equipment. Several design changes must be incorporated in the second pad as a result of knowledge gained from the first Shuttle flights. These include the ET gaseous oxygen vent collector, SSME hydrogen pre-ignition igniter and water systems modifications for pre-flight SSME shutdown and the SRB overpressure wave attenuation. Firing room three in the Launch Control Center will be modified and activated for DOD missions requiring secure operations. We plan for these actions to be completed in FY 1983 to support required launch rates including critical DOD launches scheduled.

Changes and Systems Upgrading

Management, technical and cost reviews of the Space Shuttle program and flight experience and ground testing have pointed to the need for an adequate allowance for changes and modifications which are inevitably required in a large, complex and technically demanding space system. To provide for these needs we are requesting $72.5 million in FY 1983.

This funding request represents the amount required to initiate modifications to improve reliability, increase operating efficiency and reduce cost. Specific changes and system upgrading enhancements include: the reaction control system, a redesigned auxiliary power unit, landing gear improvements, minor modifications to the SSME, tape recorder upgrading, increased Orbiter autonomy for onboard checkout, and control, procedure, and hardware changes. These would reduce turnaround time, enhance operational capability, and reduce the cost per flight.

Performance Augmentation

We are requesting $60 million in 1983 for the Performance Augmentation program to provide increased payload delivery capability to meet NASA's long standing commitments to the Department of Defense users for performance of critical missions at the Vandenberg Launch Site (VLS). This increased capability is required to support the first DOD Space Shuttle flight at VLS in 1985.

Based upon comprehensive NASA/DOD assessments of mission requirements and detailed systems engineering and tradeoff studies of several performance augmentation options, we have decided to provide this increase in performance by reducing the inert weight of the SRB's by using lighter filament wound motor case segments to replace the heavier steel. Total weight reduction is expected to be about 65,000 pounds giving an added payload advantage of about 6,000 pounds. This augmentation in performance will be applicable to missions launched from the Eastern Launch Site as well as the VLS. We believe a development schedule which would make the cases available in 1985 would provide the margins for critical missions without resorting to expensive measures to increase the payload capability that would otherwise be necessary.

SPACE FLIGHT OPERATIONS

We are requesting $126.3 million for those portions of Space Flight Operations which include the Engineering and Technical Base support, Upper Stages Development and Advanced Programs. These activities are necessary for the orderly transition to full operational status.

Engineering and Technical Base

Starting in FY 1983, Development, Test and Mission Support (DTMS), has been redefined and retitled Engineering and Technical Base (ETB). ETB will provide only the minimal (core) capability to sustain an engineering and development base to support various STS systems at JSC, KSC, MSFC and NSTL. The ETB also provides necessary equipment and supplies and performs alternative design, testing, and analyses in high technology areas of design and development. This core capability provides for a five day, one shift operation at designated institutional research and development facilities. The budget estimates for other NASA programs includes funding for the additional support required to carry out specific program activities. We are requesting $82.4 million in FY 1983 for the Engineering and Technical Base.

Advanced Programs

Advanced Programs encompasses studies and engineering investigations which continue to define future flight mission options to use the unique capabilities of the Space Transportation System starting in the mid-1980's. The FY 1983 budget request is $11.9 million for these tasks. Supporting engineering activities

and subsystem studies will also be conducted to provide the technical depth essential to the definition of these potential systems, thereby reducing future program development costs and risks. Attention will be directed toward enhancing the effectiveness of the Space Shuttle, particularly toward extending its orbital capabilities.

We are also studying and planning advanced development activities on unmanned space platforms and manned space stations should we have a need for a permanent manned presence in space. We have defined an unmanned platform which could support science, applications, and commercial experiments and then grow to become a space station by the addition of the appropriate habitation and utility modules. We are also defining, in parallel, an evolutionary Space Station program which could begin as a manned facility and grow in capability by modular add-ons.

These platforms and space station could fulfill a number of possible future functions such as servicing of other satellites in low orbits and refueling orbit transfer vehicles for emplacing and servicing satellites in geostationary orbits. They could also provide economical and versatile test facilities for R&D and science activities. A program plan is being defined to determine possible approaches.

In addition, we will increase our emphasis on understanding, quantifying, and meeting the needs of the user communities in all the above areas for which the STS is a service and support function in order to define meaningful space systems.

STS Operations Capability Development
(Upper Stages Development)

We are requesting $32.0 million in FY 1983 for Upper Stage Development. Upper Stage vehicles are required to place payloads into orbits not attainable by the Shuttle. The Upper Stages under development include the Inertial Upper Stage (IUS), a two stage solid propellant expendable vehicle capable of delivering 5000 pounds into geosynchronous orbit, and the Spinning Solid Upper Stages (SSUS), used for delivery of smaller, Delta and Atlas Centaur classes, payloads into geosynchronous transfer orbits.

The IUS program has been managed by the DOD and jointly funded by NASA and DOD. Development of the two stage configuration for geosynchronous missions has made significant progress during the year with 50 of 53 major components now having been qualified. The

first qualification motor firing has been successfully conducted and four flight motors have been cast. Shipment of IUS-2 for the first Titan launch was made last December.

The commercial development by McDonnell Douglas of the Delta-class SSUS is proceeding with the principal activity being continuation of system level qualification, and fabrication and checkout of hardware for STS flights. SBS-B, RCA-D, and RCA-C spacecraft have been successfully launched during the year, using the smaller SSUS on the Delta expendable launch vehicle.

Additionally, under Advanced Programs we are exploring advanced Upper Stages known as orbital transfer vehicles to introduce stage reuse and payload retrieval capabilities.

Research and Program Management (R&PM)

As stated earlier, the December 1981 Headquarters' organizational change provided for the Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center, and the National Space Technology Laboratories, to report to me as the program Associate Administrator responsible for the major portion of their in-house technical capability. The R&PM appropriation provides the funding needed to maintain the in-house support capability necessary to fulfill the R&D Program responsibilities assigned to centers reporting to me. Approximately three fourths of the R&PM funds pay the salaries of the highly successful and dedicated Civil Service scientists, engineers, technicians, administrative, and clerical personnel who are essential to the execution of our R&D programs. These skilled people are our most valuable asset. The remaining one fourth provides for the necessary travel and institutional supplies, materials, equipment, utilities and services to support our civil service staff ard operate the centers. The travel budget proposed for FY 1983 is the same level as FY 1982, which will result in an actual decrease in travel due to higher costs.

Johnson Space Center (JSC)

JSC is the lead center for the management of the Space Transportation System and historically has been NASA's primary center for manned space vehicle developments and space operations. An R&PM budget of $192.4 million is requested for JSC in FY 1983. It provides $137.6 million for personnel and related costs to

support 3,293 permanent civil service positions. The FY 1983 budget request also provides $50.2 million for the operation of the installation; this amount will meet expected increases in support service costs and utility rates while providing essentially the same overall level of service.

Kennedy Space Center (KSC)

KSC is the primary NASA Center for assembly, test, checkout, and launching of space vehicles. This includes refurbishment of the Space Shuttle as well as the assembly, test, checkout and launch of expendable launch vehicles.

An FY 1983 R&PM budget of $169.5 million is proposed. Of this sum $83.4 million is for personnel and related costs to support 2,112 permanent positions. The operation of installation is estimated at $84.4 million. This provides for expected rate increases in both the utility and support contractor areas. This last category provides centralized institutional and administrative services to the total center population which has grown to 14,000 including contractor and civil service employees.

Marshall Space Flight Center (MSFC)

MSFC is one of NASA's primary centers for the design and development of space systems and science and applications payloads and has the principal role for rocket propulsion within NASA.

We are requesting an FY 1983 budget of $177.7 million. The personnel and related costs of $132.5 million provides for 3,285 permanent positions. The operation of installation estimate of $41.7 million is to meet projected increases in support contractor wage rates, supplies, materials, utility rate increases, and the purchase of a replacement administrative aircraft. As you may recall, NASA initiated in the FY 1981 budget the planned replacement of three administrative aircraft and the procurement at MSFC represents the completion of that plan.

National Space Technology Laboratories (NSTL)

NSTL is NASA's prime static test facility for large liquid propellant rocket engines and propulsion systems. It also provides support to a number of tenant agencies co-located at the laboratory.

The FY 1983 budget request of $6.3 million provides essentially the same level of personnel, travel, and operation of installation suppport services as FY 1982, including projected rate increases.

Construction of Facilities
(C of F).

As the Director of Facilities will address the total agency C of F budget request, I will confine my remarks to a general overview of the Facilities Program that is directly related to Space Transportation Systems (STS) and our STS field installations. In the $100 million C of F budget request, $23.1 million is for STS major facility projects. The bulk of this request, $17.8 million, is for modifications to our manufacturing and final assembly facilities for the External Tank at the Michoud Assembly Facility.

In addition to the major projects, approximately $15 million is needed for minor projects at the STS field installations. These projects are critical requirements for maintaining and improving the usability of our facilities for research, development and launch operations.

Although the C of F requirements for STS activities are small when compared to the R&D fiscal requirements, they are absolutely essential to the overall success of the Shuttle Program. I request your continued and full support of this element of the NASA budget request.

Mr. Chairman, this concludes my prepared remarks. Thank you.

Graphics In Support of Congressional Testimony

Major General James A. Abrahamson
Associate Administrator
for
Office of Space Transportation Systems

FIG 1 STS-1 Liftoff
FIG 2 Presentation Outline
FIG 3 Flight Test Accomplishments
FIG 4 STS-2 Landing
FIG 5 Shuttle Program Progress (SSME, Launch & Landing)
FIG 6 Shuttle Program Progress (SRB & ET)
FIG 7 ET Production
FIG 8 Challenger Main Engines
FIG 9 Orbiter Delivery Schedule
FIG 10 OV-103
FIG 11 STS Flights in 1982
FIG 12 Management Initiatives
FIG 13 Robot Arm
FIG 14 STS Program Goals
FIG 15 FY 1983 Budget
FIG 16 R & PM Budget
FIG 17 CoF Budget
FIG 18 Program Summary
FIG 19 Shuttle Turnaround Projections
FIG 20 Shuttle Student Involvement Project

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

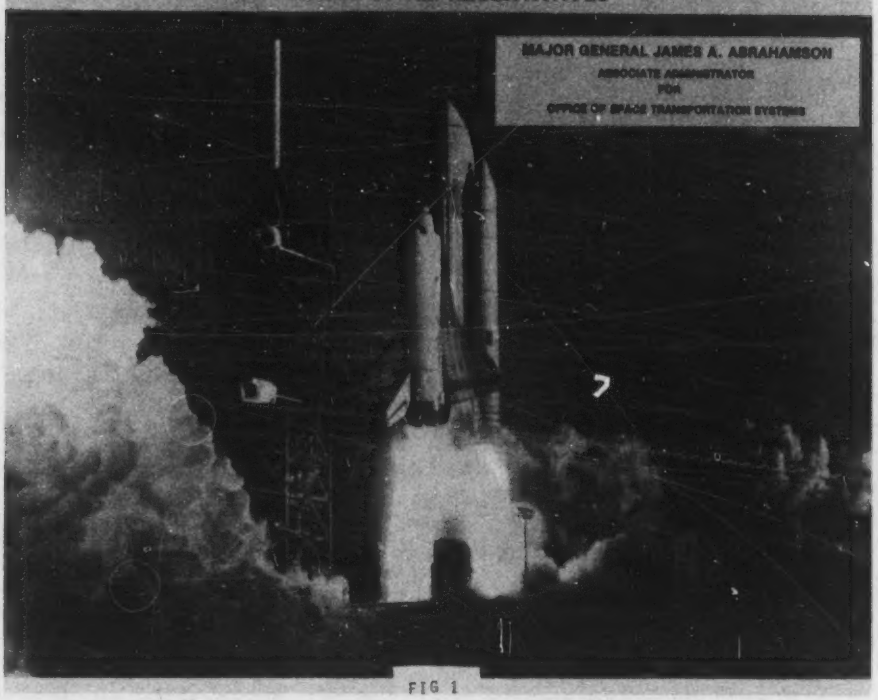


FIG 1

OFFICE OF SPACE TRANSPORTATION SYSTEMS

PRESENTATION TO CONGRESSIONAL COMMITTEE

- SHUTTLE PROGRAM PROGRESS
- ORBITER DELIVERY SCHEDULE
- STS FLIGHTS 1982
- MANAGEMENT INITIATIVES
- PROGRAM AND BUDGET PRIORITIES
- FY 1983 BUDGET
- SUMMARY

FIG 2

OFFICE OF SPACE TRANSPORTATION SYSTEMS

FLIGHT TEST ACCOMPLISHMENTS

- LAUNCHED STS-1 ON APRIL 12, 1981
  - FIRST TIME A SPACE VEHICLE MANNED ON MAIDEN FLIGHT
  - FIRST "AIRCRAFT-TYPE" APPROACH AND LANDING OF SPACE VEHICLE
- LAUNCHED STS-2 ON NOVEMBER 12, 1981
  - FIRST REUSE OF A SPACE VEHICLE
  - FIRST DEMONSTRATION OF ROUTINE CARGO-CARRYING CAPABILITY
  - FIRST USE OF A PAYLOAD MANIPULATOR SYSTEM IN SPACE
- STS-3 ON SCHEDULE FOR MARCH 22, 1982
  - MOVED FROM OPF TO VAB FEBRUARY 3, 1982
  - INTEGRATED VEHICLE IN TEST IN VEHICLE ASSEMBLY BUILDING

FIG 3

FIG 4

OFFICE OF SPACE TRANSPORTATION SYSTEMS

SHUTTLE PROGRAM PROGRESS

SSME

- RATED POWER LEVEL -COMPLETED
- FULL POWER LEVEL -FIRST CYCLE, EARLY 1982
- FULL POWER LEVEL - FOURTH CYCLE, EARLY 1883

Launch & Landing

- EXPERIENCED TEAM IN PLACE
- COMPLETE MLP-2 MODIFICATIONS, LATE 1982
- ACTIVATE DOD SECURE FIRING ROOM, LATE 1982

FIG 5

OFFICE OF SPACE TRANSPORTATION SYSTEMS

SHUTTLE PROGRAM PROGRESS

SRB

- ASSEMBLY OF STS-4 & -5 ON GOING
- COMPLETE HIGH PERFORMANCE MOTOR TEST FIRINGS, EARLY 1983
- HARDWARE IMPROVEMENTS FOR REENTRY, STS-3,-4

ET

- ET-4 SHIPPED TO KSC
- LIGHTWEIGHT TANK UNDER CONSTRUCTION & TEST
- PRODUCTION READINESS, PRODUCIBILITY IMPROVEMENTS, IMPLEMENTED

FIG 6

EXTERNAL TANK PRODUCTION

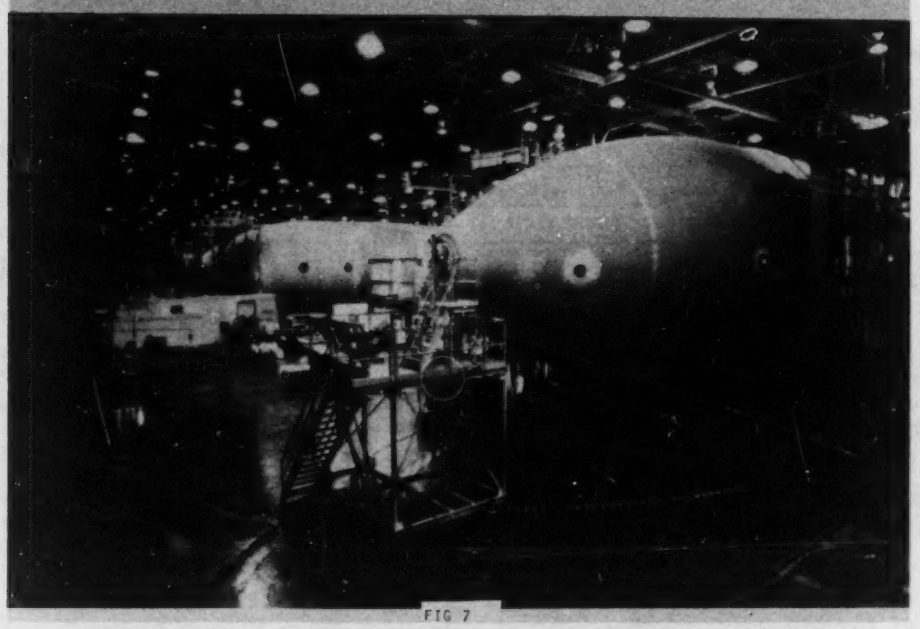


FIG 7

FINAL ASSEMBLY OF CHALLENGER MAIN ENGINES

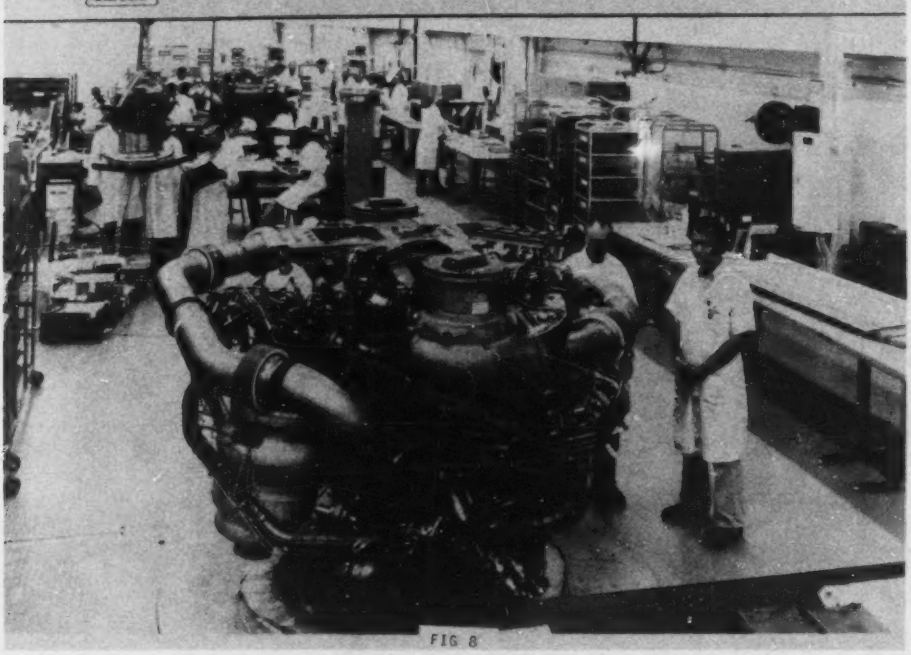


FIG 8

OFFICE OF SPACE TRANSPORTATION SYSTEMS

ORBITER DELIVERY SCHEDULE

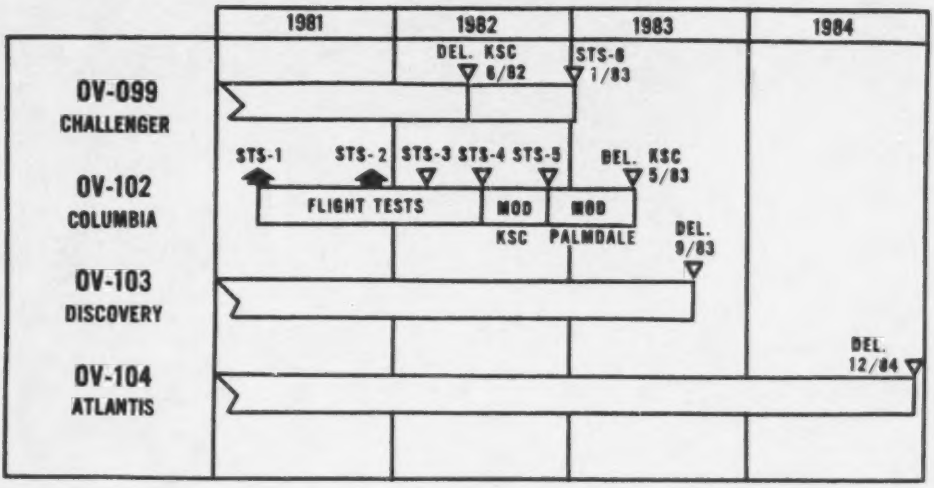


FIG 9

ORBITER 103 – CREW MODULE

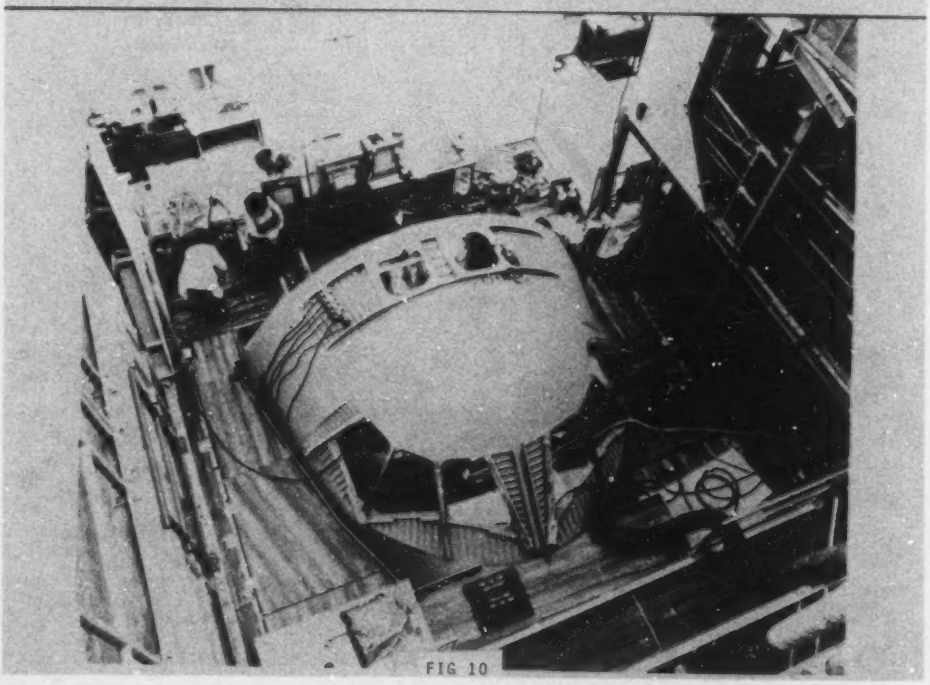


FIG 10

OFFICE OF SPACE TRANSPORTATION SYSTEMS

STS FLIGHTS IN 1982

FLIGHT	STS-3	STS-4	STS-5
DATE	MARCH 22, '82	EARLY JULY	EARLY NOVEMBER
INCLINATION/ALT	38°/130 NM	28.5°/160 NM	28.5°/160 NM
FLIGHT DURATION	7 DAYS	7 DAYS	5 DAYS
LANDING SITE	EDWARDS AFB	EDWARDS AFB	KSC
PAYLOAD	OSS-1 PALLET (ASTRONOMY & SPACE PHYSICS) MLR, GAS	DOD 82-1 MLR, GAS	SBS-C/PAM-D TELESAT-E/PAM-D MLR, GAS
CREW SIZE	2	2	4
MAJOR TESTS	INCREASE ASCENT LOADS	→	OPERATIONAL
	RMS TESTING	→	POTENTIAL EVA DEMONSTRATION
	CONTAMINATION MONITOR	CONTAMINATION/ PLUME SURVEY	
	LONG DURATION THERMAL TESTS	→	→
	ENTRY AERO AND STRUCTURAL TESTS	→	→
	AUTO TO SHALLOW GLIDE/CROSSWIND TEST	AUTO to TOUCHDOWN/ CROSSWIND TEST	AUTO TO PRE FLARE

MLR= MONODISPERSE LATEX REACTOR GAS= GET AWAY SPECIAL

FIG 11

OFFICE OF SPACE TRANSPORTATION SYSTEMS

MANAGEMENT INITIATIVES

- REVISED FINANCIAL PLANNING
- STRONG OPERATIONS EMPHASIS
- ERROR-FREE OPERATIONS GOAL
- COST INCENTIVE CONTRACTING
- MANUFACTURING MODERNIZATION
- PRODUCTIVITY IMPROVEMENTS

FIG 12

SPRAY-ON ABLATOR ROBOT

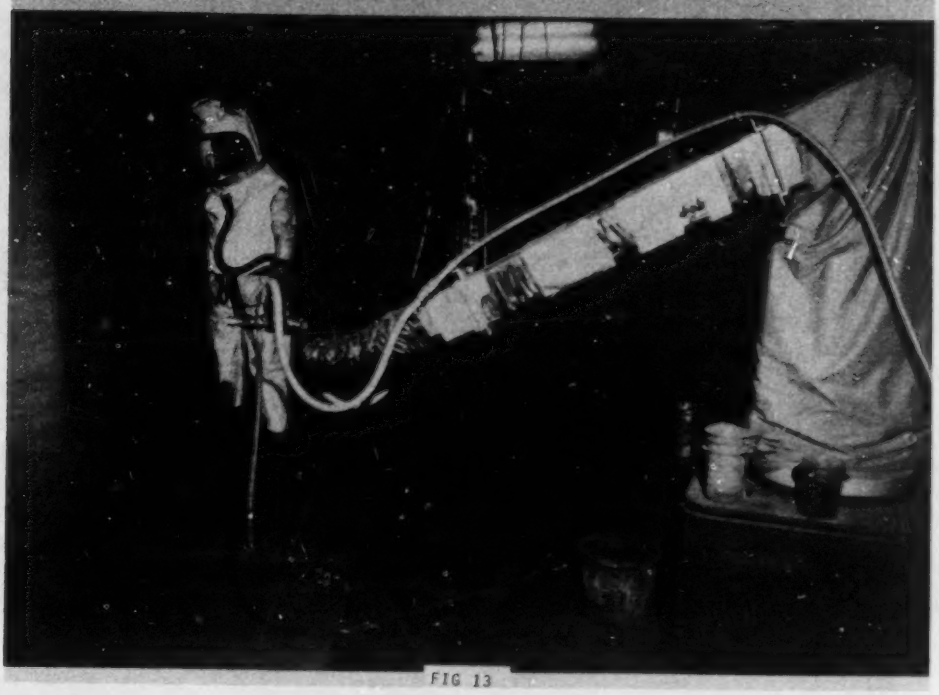


FIG 13

OFFICE OF SPACE TRANSPORTATION SYSTEMS

STS PROGRAM GOALS

- SAFE AND SUCCESSFUL STS MISSIONS
- MAINTAIN OPERATIONAL LAUNCH SCHEDULE
- REDUCE OPERATIONAL COSTS
- COMPLETE DDT&E
- MAINTAIN ORBITER PRODUCTION SCHEDULE
- COMPLETE KSC AND VAFB FACILITIES
- ESTABLISH INITIATIVES TO EXPLOIT STS CAPABILITY

FIG 14

OFFICE OF SPACE TRANSPORTATION SYSTEMS

FY 1983 BUDGET
SUMMARY OF REQUIREMENTS

(DOLLARS IN MILLIONS)

	FY 1982	FY 1983
• SPACE SHUTTLE	2163.0	1718.0
DDT & E	898.0	–
PRODUCTION	1260.0	1585.5
CHANGE & SYSTEMS UPGRADING	–	72.5
PERFORMANCE AUGMENTATION	5.0	60.0
• SPACE FLIGHT OPERATIONS	895.9	1707.0
DTMS/ENGINEERING & TECHNICAL BASE	184.0	82.4
ADVANCED PROGRAMS	8.8	11.9
STS OPERATIONS CAPABILITY DEVELOPMENT	79.3	85.4
(UPPER STAGES DEVELOPMENT)	(23.2)	(32.0)
SPACELAB	100.8	113.2
STS OPERATIONS	523.0	1414.1
• EXPENDABLE LAUNCH VEHICLES	31.2	42.8
TOTAL	3090.1	3467.8

SPACE TRANSPORTATION SYSTEMS

RESEARCH AND PROGRAM MANAGEMENT

(DOLLARS IN MILLIONS)

CENTER	CURRENT ESTIMATE FY 1982	BUDGET FY 1983
JOHNSON SPACE CENTER (JSC)	$186,635,000	$192,396,000
KENNEDY SPACE CENTER (KSC)	163,441,000	169,500,000
MARSHALL SPACE FLIGHT CENTER (MSFC)	170,840,000	177,704,000
NATIONAL SPACE TECHNOLOGY LABORATORIES (NSTL)	$ 6,086,000	$ 6,252,000

SPACE TRANSPORTATION SYSTEMS

FY 1983 BUDGET ESTIMATES
CONSTRUCTION OF FACILITIES

• SPACE SHUTTLE	$21,405,000
MAF	17,845,000
KSC	1,700,000
VARIOUS LOCATIONS SHUTTLE-UNIQUE PROJECTS (LESS THAN $500,000 EACH)	1,860,000
• PAYLOADS	$1,740,000
KSC	1,740,000
• MINOR REPAIR PROJECTS	
59 PROJECTS AT (LESS THAN $500,000 PER PROJECT)	$14,650,000
TOTAL	$37,795,000

FIG 17

OFFICE OF SPACE TRANSPORTATION SYSTEMS

PROGRAM SUMMARY

- STS-5 BEGINS OPERATIONS
- MAINTAIN PRODUCTION FOR 32 FLIGHTS THROUGH FY 1985
- 24 FLIGHTS PER YEAR CAPABILITY BY FY 1988
- ORBITER DELIVERIES ON SCHEDULE
- PERFORMANCE CAPABILITY IMPROVEMENTS
  - 109% MAIN ENGINE (CERTIFIED EARLY 1983)
  - FILAMENT WOUND CASE (FIRST FLIGHT LATE 1985)
  - HIGH PERFORMANCE BOOSTER (FIRST FLIGHT MID 1983)
  - LIGHTWEIGHT TANK (FIRST FLIGHT EARLY 1983)
  - MANNED MANUVERING UNIT DEVELOPMENT (SUPPORT SOLAR MAXIMUM REPAIR)
- FACILITIES AT KSC AND VAFB
  - SUPPORT VAFB OPERATIONAL DATE (LATE 1985)
  - COMPLETE SECOND KSC PAD (LATE 1986)

FIG 18

OFFICE OF SPACE TRANSPORTATION SYSTEMS

SHUTTLE TURNAROUND PROJECTIONS

	NET WORKDAYS OF PROCESSING			
	OPF	VAB	PAD	TOTAL
STS-2	72[1]	19	34[2]	125
STS-3	55	15	28	98
STS-4	36	13	25	74
STS-5	33[3]	13	24	70
:	:	:	:	:
STS-8[4]	26	10	17	53

1/ACTUAL PROCESSING INCLUDED 27 DAYS OF POWER OFF MODS

2/ACTUAL PROCESSING INCLUDED 36 DAYS FOR N^2O^4 SPILL CLEANUP AND APU LAUNCH DELAY

3/GROSS PROCESSING INCLUDES 28 DAYS FOR POWER OFF MODS

4/THIRD FLIGHT OF ORBITER 099; INCLUDES 102 PROCESSING EXPERIENCE

FIG 19

SHUTTLE STUDENT INVOLVEMENT PROJECT FOR SECONDARY SCHOOLS

- STIMULATE THE STUDY OF SCIENCE AND ENGINEERING BY ENGAGING STUDENTS IN A COMPETITION TO DEVELOP EXPERIMENTS SUITABLE FOR FLIGHT ABOARD THE SPACE SHUTTLE (86,000 REQUESTS)
- STUDENTS IN GRADES 9 TO 12 IN ALL US PUBLIC, PRIVATE, AND PAROCHIAL AND OVERSEAS SCHOOLS, INCLUDING US CIVIL AND MILITARY ESTABLISHMENTS, AND TERRITORIES
- MOST EXPERIMENTS WILL FLY IN ORBITER MID-DECK STOWAGE LOCKERS RECEIVE UP TO ONE HOUR OF CREW INVOLVEMENT
- 200 TEACHERS VOLUNTEER AS ADVISORS TO REGIONAL WINNERS
- 120 SCIENTISTS, ENGINEERS, AND EDUCATORS VOLUNTEER AS REGIONAL AND NATIONAL JUDGES
- 200 SCIENTISTS, ENGINEERS, AND EDUCATORS VOLUNTEER AS ADVISORS AT REGIONAL CONFERENCES
- 10 NSTA MEMBERS VOLUNTEER AS REGIONAL DIRECTORS TO ACCEPT PROPOSALS, SOLICIT JUDGES, AND PLAN REGIONAL CONFERENCES
- WINNERS PAIRED WITH CORPORATE SPONSORS TO DEVELOP EXPERIMENT
- PROVIDES FUNDING FOR TRAVEL, HARDWARE DEVELOPMENT, AND POST-FLIGHT ANALYSIS AND REPORTING

FIG 20

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE HEARING BEFORE THE HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS ON FEBRUARY 10, 1982 TO GENERAL ABRAHAMSON.

QUESTION M-1:

(a) Could you elaborate on the most recent report of the Aerospace Safety Advisory Panel related to the Space Shuttle?

(b) Are you aware of any unresolved safety issue concerning the Space Shuttle?

(c) Do the results of the report hold true for subsequent Space Shuttle flights as well?

ANSWER M-1:

(a) The Panel presented their annual report and discussed their assessments, conclusions, recommendations and future activities with Dr. Mark and Mr. Beggs on January 21, 1982. To assure that we obtain their council on a timely basis, we maintain a continuing dialogue with them. The report provided, among other things, (1) five findings, (2) nine recommended actions, and (3) areas of concentration during 1982. Dr. Stanley Weiss, Associate Administrator for Space Transportation Operations and I have also met with the Panel and discussed the report and their response to it. In most cases, the Panel's concerns and recommendations are similar to our own thinking. For example, the Panel noted that NASA incidents/accidents demonstrate poor local supervision of specific procedures and a vague line of authority for essential tasks. We have been greatly concerned as well, and a number of efforts are underway at various NASA and contractor locations to improve our safety performance, including safety workshops, examination of current safety policies and their implementation, and special programs by each of the Associate Administrators and a personal commitment to safety by each Center Director. It is our desire that the Panel stay abreast of all program risks to determine whether or not our program remains reasonable. This is also in line with a Panel recommendation. As part of this activity the Panel will participate in program reviews leading to launch.

(b) With the successful completion of the first two Shuttle missions and our continuing aggressive and systematic safety program we are not aware of any unresolved safety issues. We have asked the Panel to review the structural adequacy of the Shuttle system and the safety implications associated with the use of lightweight External Tanks and lightweight Solid Rocket

Motor cases. There are the same residual risks since there is always a degree of risk associated with using solid rockets and the single layer thermal protection system on the Orbiter. Each residual risk has been subjected to in-depth scrutiny to make sure that the effects and likelihood of occurrence have been minimized.

(c) The Panel's report addresses current and future Shuttle activities with emphasis on going from the DDT&E period to the fully operational period. Therefore, the assessments, conclusions and recommendations do relate to subsequent Space Shuttle flights. For example, the Panel's discussion of streamlining turnaround procedures and expanding the performance envelope along with redline assessments are continuing activities now and in the future.

QUESTION M-2:

NASA has again included funds for Changes and Systems Upgrading activities?

(a) Is this funding still considered to be program reserves?

(b) Is this funding still controlled by the Administrator?

ANSWER M-2:

(a) The FY 1983 Budget request for Shuttle Changes and Systems Upgrading is $72.5 million. These requested funds are considered a program reserve but with the specific intent of providing an allowance for operational improvements to the Space Transportation System. The FY 1983 amount represents the estimated requirements to initiate modifications now under consideration which have been identified to improve reliability, increase operating efficiency and reduce the cost of operations. Changes and Systems Upgrading areas of interest include modifications to flight and ground systems; design and development of hardware/software systems which meet requirements for improved safety, reliability, performance and cost-effectiveness; and changes which will reduce operational costs by extending operational life, facilitating improved mission-to-mission turnaround time, and achieving improved mission performance margins.

(b) The Shuttle Changes and Systems Upgrading funds are controlled by the Administrator in the sense that, prior to allocation to either development or production program requirements, the need for and proposed use of these resources are reviewed with the Administrator and

other members of general management. However, the principal level of control is at the Associate Administrator's level.

QUESTION M-3:

The FY 1983 budget request for Space Transportation Systems was projected to be $3,023,000,000 in March 1981 including a projection for Centaur development. The current budget request is $3,467,800,000, an increase of more than $440 million and does not include Centaur.

(a) Could you elaborate on the need for increased resource requirements for the Space Transportation System?

(b) What is being done to improve resource requirements projections?

(c) Are the program reserves being budgeted in FY 1983 commensurate with program schedule and technical risk?

ANSWER M-3:

(a) The current FY 1983 budget request for the Space Transportation System programs, which include the Space Shuttle, Space Flight Operations and Expendable Launch Vehicles, is $445 million higher than the FY 1983 estimate in the runout of the FY 1982 Amended Budget. This total of $445 million is comprised of increases of $187 million in the Space Shuttle; $243 million in Space Flight Operations activities; and $15 million in Expendable Launch Vehicles.

The Shuttle increase is primarily due to changes in three program areas: the $60 million included in the current FY 1983 Budget request for the filament wound case development (there were no funds in the FY 1982 Amended Budget runout) to provide performance augmentation for the Shuttle; an additional $172 million for Spares and Equipment requirements, primarily due to price and quantity increases for Orbiter flight and crew equipment spares, external tank and solid rocket booster rate tooling and external tank producibility and production readiness efforts; and a $55 million reduction for Shuttle/Centaur modifications related to the decision to discontinue the development of the Centaur upper stage. Other increases totaling approximately $73 million have occurred in a number of Shuttle activities including systems integration efforts, post OFT data analysis, modifications to Orbiter 102, spacesuit hardware production, simulator/trainer modifications, and SMM mission unique

requirements. These increases have been offset by an allocation of a like amount from the previous FY 1983 estimate for the Change and Systems Upgrading budget.

In the Space Flight Operations line item, the increase of $243 million is comprised of increases of approximately $280 million for Shuttle Operations manpower and hardware; $17 million for multi-mission payload support equipment and manpower increases required for the upgrading of the Mission Control Center capability; and $15 million for Spacelab development for systems integration, flight hardware modifications and spares and ground support equipment. These increases have been partially offset by decreases of $60 million in upper stages development and operations related to the discontinuation of the Centaur upper stage development and $8 million in Payload Support Operations requirements.

The Shuttle Operations increase of $280 million includes an additional $135 million for Johnson Space Center activities for mission operations manpower and to procure orbiter vehicle spares and equipment which increased in quantities as well as unit costs, and a $115 million increase for Shuttle processing and launch operations manpower at the Kennedy Space Center. The manpower increases at both Centers result from the requirement to maintain the current level of manpower as the STS transitions from development to the operational era. These levels of manpower established by STS-1 and STS-2 experience must be maintained until additional experience in operating the STS is gained and anticipated efficiencies are realized which would allow for reduced manpower requirements. Production of solid rocket boosters and external tanks for operational flights have increased by approximately $30 million due to additional labor and subcontractor costs based on experience during the development phase.

Finally, the Expendable Launch Vehicle requirements have increased by $15 million for Delta vehicle procurement and launch services.

(b) Resources requirements projections have been a problem source in the past primarily due to our inability to estimate adequately the impact of changes and problems in our development activities. The development phase has progressed to the point that we now understand the program requirements much better and thus are in a position to identify more accurately funding requirements.

In addition, we are now fully informing Center project management of anticipated funding reserve availability so that they can plan their activities accordingly,

including the provisions for a change allowance. On this basis, Center project personnel will know exactly the total funding availability within which they will have the responsibility to manage the program. By assigning this increased responsibility to the Center project personnel, we believe that we can develop a greater sense of involvement in the budget process to the lowest practical management level which will, in turn, give us better accuracy in developing future resources requirements.

(c) While additional program reserves would always increase confidence, we believe that, barring major unforeseen problems, the total reserves included in the budgt request are commensurate with schedule and technical risks. We may, however, find it necessary when we move to FY 1983 to reallocate the available reserves among the various program activities.

QUESTION M-4:

What succcess are you having in reducing turnaround time?

ANSWER M-4:

This subject was addressed by General Abrahamson during his testimony regarding data shown on the attached chart.

As we proceed with the processing for the third flight, there have been significant reductions in the times required to process and recycle the STS elements. A comparison of the total number of work days required for the turnaround of STS-2 and the planned launch of STS-3 reveals a reduction of approximately 22 percent. Projected reductions in turnaround times for subsequent flights include an additional 24 percent for STS-4 and an additional 28 percent by STS-8. Achieving these goals will result in a processing flow of approximately 53 working days for STS-8.

Circumstances contributing to these projected reductions include: increased familiarity with the vehicle hardware resulting in improved productivity; plans for phased reduction and/or elimination of test requirements; and continuing procedural changes reflected increased knowledge and understanding of the vehicle and its systems.

QUESTION M-5:

(a) What additional facilities not currently in the budget are required to meet 24 flights per year?

(b) Are there any of these that should be in the FY 1983 budget?

ANSWER M-5:

(a) There are no additional facilities currently known to be required to support a 24 year launch rate that should be in th FY 1983 budget. However, we consider the third mobile launch platform at KSC as a strong item for potential inclusion in the FY 1984 CoF Budget request. Other facilities at KSC which are being considered in our FY 1984 Budget planning include the Bostic paint facility, APU hot fire facility and the Logistics and GSE Storage Facility. To support external tank production at MAF, several rate-related facilities are being reviewed in the development of the FY 1984 budget. These include modifications to improve production flow, storage of completed tanks and other projects to assure the rate production capability. All of these will be carefully reviewed as the FY 1984 budget is formulated.

(b) No.

QUESTION M-6:

We noted that Development, Test and Mission Support (DTMS) account has been redefined and retitled Engineering and Technical Base (ETB). We are not quite sure what has happened here especially with the large funding decrease.

(a) Could you please explain in detail the function of this line?

(b) Is this a real savings or is it merely shifting the cost to other accounts and programs?
(c) What will the people and contractors that DTMS supported be doing from here on out? Will they be kept on board and paid for by other projects, or let go? Will they be reassigned to Shuttle operations activities?

ANSWER M-6:

(a) In the Committee on Science and Technology report on the NASA FY 1980 Authorization Bill, it was requested that the agency submit a method which would address future assurances for the Shuttle operational period that: "(1) assure adequate support of the research and development institutions, (2) provide sufficient visibility of program support costs, and (3) assure that all feasibly identifiable costs are charged to benefiting program." On August 5, 1980, NASA notified the Committee by letter of its plan to start the

Engineering and Technical Base in FY 1983 to comply with their request.

Based on this request and starting in FY 1983, the Engineering and Technical Base will fund only the R&D capability that is necessary to continue a basic development base in support of various Space Transportation Systems program elements. This capability will be maintained at the Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and the National Space Technology Laboratories. Any demands in excess of this R&D core capability will be funded by the benefiting programs, such as Shuttle Production and STS Operations.

Using this approach, Johnson Space Center will support a one-shift operation of its laboratories. The Central Computer Complex will utilize a two-shift operation. The funding for the Center Operations will be shared equally between the Engineering and Technical Base and the benefiting program, STS Operations and Shuttle Production.

Kennedy Space Center will have a minimal manpower level to maintain, develop, and capitalize on the research and development technologies available to enhance space flight hardware, ground processing and support systems.

For the Marshall Space Flight Center and the National Space Technology Laboratory, they will be extending their basic core capability of maintenance and operation of the automatic data processing equipment, various facilities, test stands, and providing laboratory services.

(b) By definition of the Engineering and Technical Base (ETB), all activities over and above this core capability that represent direct program dedicated capability (such as those required for Space Transportation Systems Operations or new development activities conducted at these Centers) will be budgeted by and charged to the benefitting programs. It is a different management concept. It will not produce immediate savings. However, in the future, the elimination of marginal support requests should eventually produce real savings.

(c) The support contractors are budgeted at basically the same level from FY 1982 to FY 1983. However, we are undertaking management efforts to make these support operations more efficient, thereby allowing for future reductions in staffing levels and resource requirements budgets. The Engineering and Technical Base will include approximately 39 percent of the FY 1982 DTMS support contractor level. The benefiting programs, particularly STS Operations, will fund the

majority of the balance of the support contractor manpower that was previously funded under DTMS in FY 1982.

QUESTION M-7:

In the advanced programs area, we see an increase over FY 1982 but we are concerned that the level is too low. What were the Center requests? What was the NASA request to OMB? Do you feel this request is adequate?

ANSWER M-7:

Center Requests (including Phase B Studies)	Center Requests (Without Phase B Studies)	NASA Request To OMB
22.1	12.7	11.9

This amount provided for in the budget is adequate to perform a constrained effort. This level of funding provides funds for generating concepts of new space systems and for some definition of improved systems, techniques or space facilities that capitalize on the new capabilities in space transportation brought into being by the STS. The amounts provided will not allow for pace of definition and advanced development activities as might be desirable.

QUESTION M-8:

What activities will be supported by your Advanced Program funding?

ANSWER M-8:

	FY 83 ($M)	
UNMANNED PLATFORMS	3.0	Continue studying experimental GEO platforms and growth versions of LEO platforms. Continue development phase of tethered satellite system. Initiate limited key advanced developments.

MANNED SPACE STATION	4.0	Continue regenerative life support test and evaluation. Initiate some limited life support development. Continue Space Station Phase A studies.
ORBITAL SERVICES	2.0	Continue large structures investigations. Initiate key satellite services engineering developments. Investigate orbital experiments candidates. Preliminary study of automated orbital services.
ADVANCED TRANSPORTATION	2.0	Continue studies of earth-to-orbit vehicles that may be superior to the baseline STS (for selected applications) with respect to payload weight, payload size, or cost-effectiveness when manned operations are necessary. Continue investigations of high-performances, reusable upper stages.
ADVANCED CONCEPTS	0.9	High risk, high potential preliminary concepts studies.

QUESTION M-9:

Could you elaborate on the new starts in your FY 1982 packge on initiatives which did not make the 1983 budget submission?

ANSWER M-9:

The major study efforts that were in the "Phase B" definition phase in FY 1982 were the following:

Space Platform
Power Extension Package
Tether System
Solar Electric Propulsion System

These potential candidates for FY 1983 new starts were deferred by NASA to later years and all but SEPS are being continued in the definition or advanced development phase in FY 1983.

QUESTION M-10:

This Subcommittee continues to be interested in increased power supply for the Space Transportation System.

(a) Could you elaborate on the relative priority of the Power Extension Package and the 25 kw Power Module?

(b) Has NASA considered these developments as part of the STS changes /systems upgrading budget line item?

ANSWER M-10:

NASA internal planning assigns the Space Platform (SP), which incorporates design concepts of the 25 kw Power Module, a higher priority than the Power Extension Package (PEP). The broad base of scientific and applications users have focused their requirements on long duration free flight missions more so than on extended duration Orbiter missions. Further, the user demand for Orbiter services for launch and deployment operations exceeds the demand for other missions which would utilize the PEP system. The Space Platform, which has a high level of user support, continues to be studied under system definition studies conducted under the A-109 process. The Space Platform continues to be a high priority Space Transportation Systems candidate.

The Power Extension Package has completed systems definition and awaits flight development based on flight requirements as they occur. At the subsystem level we are continuing advanced developments of large area solar cells because of their potential system economies.

(b) The Space Platform was not considered in the recent budgetary process for the STS Changes/Systems Upgrading budget line item because it represents a significant new start and unique system capability.

QUESTION M-11:

The House/Senate conference report on the FY 1982 budget request directed NASA to procure the long-lead material necessary to maintain the most efficient production schedule for OV-105.

(a) What amount of FY 1982 funds are being used for OV-105 long lead procurement?

(b) What amount of funds would be required in FY 1983 for an efficient 5th orbiter production?

ANSWER M-11:

(a) The FY 1982 Operating Plan does not contain funds specifically for OV-105 long lead procurements.

(b) An accelerated OV-105 production schedule could result in a 1986 delivery date. If minimum funding were available in FY 1982, the FY 1983 amount to support a 1986 delivery would be in the $200 million range.

QUESTION M-12:

(a) If certain Orbiter 104 production activities scheduled for FY 1982 have to be rephased as discussed in the budget books, what are the cost and schedule impacts?

(b) What amount of additional funding would be required in FY 1983 to assure maintenance of OV-104 delivery schedule.

(c) What is the magnitude and impact of eliminating the funding of long-lead hardware for OV-105? Realistically, how much longer can the decision to buy OV-105 be delayed?

ANSWER M-12:

(a) At present, there are no plans to rephase OV-104 production activities scheduled for 1982. Previous assessments of a six-month schedule delay indicated that the costs at completion could increase by approximately $75 million - $100 million.

(b) The current budget request contains adequate funds to maintain OV-104 on a December, 1984 delivery schedule.

(c) If long lead hardware funding for OV-105 is not available until FY 1983, the vehicle delivery would slip to 1987 or 1988, depending on the amount of 1984 funding available. The EAC impact deferring long-lead funding until 1983 would be in the $200 million - $300 million range. From a production efficiency view point in terms of manpower utilization, it would have been more desirable to initiate procurement of long-lead items in FY 1982 and start of manufacturing activities in FY 1983. However, there is no inherent reason why procurement of one or more additional orbiters cannot be delayed, although there are cost and schedule impacts.

QUESTION M-13:

In our legislative report for NASA's FY 1982 authorization we asked for a review by NASA and the Air Force of the need for additional orbiters looking towards the possibility of a block purchase. What is the status of that review?

ANSWER M-13:

In our response to that action, we stated that NASA was participating under the direction of the Office of Science and Technology with the DOD and other agencies in a launch vehicle study. At the time we replied, it was projected that the study would be completed before the end of 1981; however, it is now estimated that we will complete the initial study in the Spring of 1982.

In the meantime, NASA is proceeding with a study effort with Rockwell International, designed to look at the possibilities, benefits, trade-offs, etc., of implementing a block buy of OV-105. The block buy would probably utilize two contractual instruments, a ceiling or other contract modification for the OV-104 contract along with a price commitment for OV-105. We will make available the results of the study as soon as possible.

QUESTION M-14:

What is the status of the Space Transportation Company's proposal to the government regarding STC's offer to provide funds to purchase a fifth orbiter?

(a) In your view, is the proposal complete or does it lack critical components?

(b) What are your views on the proposal?

(c) Are there other similar industry proposals which the government is considering?

ANSWER M-14:

(a) The formal proposal of the Space Tranportation Company to purchase and operate OV-105 has just been received by NASA. Prior to this receipt, we had access to only partial and incomplete data. We are currently in the process of reviewing the formal proposal and identifying areas where additional or further critical information is required.

(b) My initial reaction is that, while this is an intriguing proposal, the actual implementation of such a scheme needs much closer evaluation. Priorities, government rights vs. company rights, vehicle loss, are

just some of the extremely difficult areas that must be addressed. However, I am reserving my final opinion until I have had more chance to study the proposal.

(c) None that we are aware of at this time.

QUESTION M-15:

(a) Since the authorization hearings last year, has there been any change in the schedule commitments for delivery of the production orbiters?

(b) What are the delivery schedules envisioned by the budget request?

(c) Do the currently envisioned production orbiter delivery schedules satisfy Department of Defense requirements?

(d) Did NASA request funds for the 5th orbiter in the 1983 budget?

(e) What funding level and management decisions would be required to maintain the most efficient production schedule?

ANSWER M-15

(a) There has been no change in schedule commitments for delivery of the production orbiters. However, within the available funding for FY 1982, priority has been assigned to maintaining the delivery schedule for Orbiter 099 and Orbiter 103. This may cause some Orbiter 104 activities scheduled for FY 1982 to be rephased, which could have some potential impact on the Orbiter 104 delivery schedule. Our objective, however, is to maintain the OV-104 schedule, within our present budget, if at all possible.

(b) The schedules supported by the budget request are:

OV-099	June 1982
OV-103	Sept. 1983
OV-104	Dec. 1984

These orbiter vehicle delivery dates have been in effect since October 1979.

(c) Yes, the current orbiter delivery schedules satisfy both the DOD Vandenberg Air Force Base (VAFB) facility operational requirements and DOD mission requirements. Current plans provide for transferring Orbiter 103 in early 1985 from the Kennedy Space Center to VAFB to

support the VAFB operational date of October 1985. Prior to the activation of VAFB, DOD missions will be flown on vehicles OV-102 and OV-099 from KSC.

(d) The FY 1983 Congressional budget does not identify funds for a fifth orbiter.

(e) The current delivery schedule for OV-099, OV-103, and OV-104 is the most efficient production schedule given the past and present budget posture.

The orbiter contractor, Rockwell, believes that--within present basic tooling and facility constraints--the most efficient production schedule for additional orbiters would be to provide delivery of orbiters approximately 15 months apart.

QUESTION M-16:

Please provide for the record a production orbiter funding breakdown by fiscal year and by orbiter vehicle.

ANSWER M-16:

Vehicle Funding Estimates*
(Millions of Dollars of the FY 1983 Budget)

Vehicle	Prior	FY82	FY83	FY84	FY85	FY86	FY87	EAC
OV-099	978	141						1119
OV-102	MOD 64	57	64					185
OV-103	490	439	207	26				1162
OV-104	166	200	408	392	150	12		1328

*Includes the Orbiter vehicle, the Main Engines, and supporting equipment--such as the remote manipulator arm.

QUESTION M-17:

Does the contractor agree that there is adequate production funding in FY 1982 and FY 1983 to maintain the orbiter delivery schedules?

ANSWER M-17

Although there are minor differences in the project level expenditure plans, the contractor's projected funding requirements for FY 1982 and FY 1983 can be covered in the FY 1983 Congressional budget request.

QUESTION M-18:

(a) What is the level of change orders being experienced on the orbiter production contract?

(b) Is this level of change order activity excessive?

ANSWER M-18:

(a) The current change order traffic is running less than 8 percent per year. The change order activity has been going down. One year ago, in FY 1981, the change level was approximately 20-25 changes per month. Presently, we are experiencing approximately 10-15 change orders per month.

(b) We feel the level of change orders is not excessive and we continue to maintain close management surveillance at all levels to minimize changes. Changes resulting from flight tests are very difficult to project in an complex development program such as the Spaace Shuttle Program. However, the small number of mandatory changes that resulted from the first two flights give us reason to be optimistic about the future. We will continue to evaluate changes that affect vehicle safety and performance and make conscientious decisions relative to their implemention.

QUESTION M-19:

What is the status of a new thermal protection system for the production orbiters?

ANSWER M-19:

For OV-103 and OV-104, it is planned to replace the LI-2200 tiles (22 lbs/cubic foot) with FRCI-12 tiles (12 lbs/cubic foot). Characterization of the FRCI-12 material has been completed. The use of FRCI-12 in lieu of LI 2200 will save approximately 1000 pounds of weight per vehicle.

An evaluation was made of the potential use of FRCI-8 in lieu of LI-900 on production vehicles. This effort has been terminated because of projected limited benefits in thermal characteristics and minimal weight savings.

Advanced flexible reusable surface insulation (AFRSI) is being developed for use in place of a large number of thin white tiles on OV-103 and OV-104. It will also be installed on the OV-099 OMS pod. The use of AFRSI offers significant advantages over the white tile due to its ease of manufacture and installation, as well as its durability.

A spectrum of metallic and advanced carbon-carbon materials were studied as alternate TPS concepts for orbiters. A limited research and evaluation program is being conducted on these concepts.

QUESTION M-20:

(a) When is full power level engine certification planned for completion?

(b) What is the current status?

(c) Does the current schedule satisfy mission requirements?

(d) Are there adequate reserves to cover unforeseen problems or test failures?

ANSWER M-20:

(a) The SSME full power level certification is scheduled for completion by the end of February, 1983.

(b) We have recently completed the first of four cycles in this certification program.

(c) Completion of this certification on schedule will support mission requirements.

(d) We feel we are maintaining tight but adequate hardware margins within the resources available to the program in FY 1982. Resource requirements identified for FY 1983 provide addditional margin and program assurance.

QUESTION M-21:

Do current main engine delivery schedules support Orbiter delivery schedules?

ANSWER M-21:

Current engine delivery schedules will assure that engines are available when required for installation on each Orbiter.

QUESTION M-22:

Is there currently a production gap in the main engine program?

ANSWER M-22:

Our current approved engine delivery plans do not have a production gap. Several options that have been proposed have delivery gaps, but these have not been selected. We are assessing several options in this area at the present time and plan to implement an engine production plan that accelerates engine deliveries without generating a production gap.

QUESTION M-23:

(a) What is the status of the lightweight tank development program?

(b) What is the unit cost impact of the lightweight design?

(c) Is the lightweight tank development on schedule?

ANSWER M-23:

(a) Development of the lightweight tank is nearing completion. Final structural testing will be completed in March 1982 and component verification by July 1982. All structural tooling modifications are complete and support manufacturing schedules to meet program hardware delivery requirements.

(b) The projected average unit cost impact of the lightweight design is about $1.0 million. This is an increase of $.2 million from last year's estimate.

(c) Development of the lightweight tank is on schedule.

QUESTION M-24:

Could you elaborate on the major efforts underway to reduce the production costs and schedule for the External Tank?

ANSWER M-24:

A comprehensive program is underway by the contractor and NASA to reduce costs and improve schedules that includes:

Producibility - Good progress is being made to reduce the work on about 400 Thermal Protection ablator parts with new technology from MMC, MIT, and MSFC. Our policy is to reduce recurring costs over 400 to 500 tanks (not just the contract with MMC for $60 million over 54 tanks). Good progress has been made along these lines.

Production Readiness - Transition from development to production mode. Achievement of required production rate through establishing standards, tooling and production flow optimization, software improvements, etc.

Productivity Enhancement - Includes systems requirement changes, design improvements, weight reduction, etc.

Advanced Manufacturing Technology - Many automated improvements already implemented. Studies underway include insulation improvements/reduction, plasma arc welding, automated weld inspection, and robotics.

Contract Initiatives - Conversion of contracts from cost plus award fee to cost plus incentive fee is underway. Incentives on touch and support labor reduction, subcontractor costs, flight performance, and delivery schedule are planned.

QUESTION M-25:

(a) Could you elaborate on the schedule for the second mobile launch platform versus requirements?

(b) When is initiation of the third mobile launch platform required?

ANSWER M-25:

(a) The second mobile launch platform will be operationally ready September 30, 1982 to support the hardware deliveries, facility utilization and workshift planning for the STS-6 launch. The first mobile launch platform will be unavailable for use during this launch, as it will be utilized for the STS-5 launch and then will be refurbished for the STS-7 launch; the interval between launches does not allow for the successive use of the same mobile launch platform.

(b) The design work for the third mobile launch platform is required during FY 1982. Initiation of long lead procurements and the stripping of Apollo accoutrements not needed for Shuttle launches will begin in FY 1983. CoF funding will be requested in the FY 1984 Congressional Budget. These actions are necessary to support the flight rate and shorter flight intervals starting in September 1986.

QUESTION M-26:

The budget books discuss a number of changes in operational readiness dates for several facilities in connection with a reprogramming for temporary office housing.

(a) Could you elaborate on these plans?

(b) Could you elaborate on the FY 1982 operating plan increase for launch support activities at KSC, $61 million, to cover the increased costs of supporting Shuttle launch processing?

ANSWER M-26:

(a) Use of the VAB for SRB stacking and handling has inherent hazards to personnel housed in the VAB. With increased work shift planning to achieve faster turnarounds, it is necessary for safety and schedule to remove all personnel from the VAB who are not essential to the hands-on processing. Concern for these personnel became pre-eminent. To accommodate their removal from the area and to lessen the cost increase, other facility (principally the second launch pad) and GSE items were deferred. Deferral of the readiness date of the second launch pad to September 1986 is commensurate with changes in the KSC flight rate.

(b) The causes for this growth in requirements are related to the support for launch processing operations and for facility and equipment modifications needed to resolve problems experienced during the first two Shuttle launches. Operations support increases included additional manpower needed for critical path vehicle processing schedules, realignment of responsibilities for Shuttle support operations to Shuttle DDT&E from Development, Test and Mission Support (DTMS), and provision for launch scrubs and cryogenic tanking tests. Facility and equipment modifications have included: the extension into FY 1982 of the gaseous oxygen vent collector and swing arm rework; SRB ignition overpressure modifications; and, changes to access platforms on the pad for the repairs required by the orbiter forward reaction control system nitrogen tetroxide spill before the STS-2 launch.

QUESTION M-27:

(a) Could you elaborate on the status of NASA's plans for a shuttle upper stage?

(b) If NASA pursues the short wide-body Centaur, will you conduct a competitive procurement?

(c) What would be the justification of a sole source procurement?

ANSWER M-27:

(a) Current NASA plans are to launch Galileo and ISPM on the 2-stage IUS with the addition of a third stage kick motor to be provided by the Galileo and ISPM spacecraft program. The IUS Program is proceeding on that basis.

(b) No. NASA does not, at this time, have any requirements for a short wide-body Centaur. If NASA were directed to develop a short wide-body Centaur, we would not conduct a competitive procurement.

(c) The short wide-body Centaur is a modified version of the current Centaur being flown on the Atlas Centaur expendable launch vehicle. General Dynamics is the only company building, or who has built, Centaur vehicles. Therefore, the contract for the short wide-body Centaur would be procured from General Dynamics on a noncompetitive basis.

QUESTION M-28:

(a) What is the cost and schedule impact on the Galileo and ISPM programs of the short wide-body Centaur as compared with the IUS?

ANSWER M-28:

In performance, the short wide-bodied Centaur has double the capability of the two-stage IUS to geosynchronous orbit (10,000 lbs vs 5,000 lbs). However, for the Galileo mission the short Centaur requires an earth gravity assist trajectory, just as the two-stage IUS does, which results in equivalent trip time and increases the Galileo mission costs to about the same as the IUS. The cost comparison results in an advantage of approximately $250 million to the IUS option. This advantage is based on a comparison of the total cost of the Centaur versus the costs required to modify the IUS for planetary missions. The short wide-body Centaur will increase the science return at Jupiter by allowing eleven satellite encounters as compared to six encounters with the IUS; however, approximately 85-95 percent of the original science objectives can be accomplished by the IUS launch mode.

QUESTION M-29:

(a) What is the current unit cost estimate for an IUS?

(b) What would be the projected unit cost for the wide-body Centaur?

(c) What would be the projected unit cost for a short wide-body Centaur?

ANSWER M-29:

(a) The unit cost, hardware only, for the IUS vehicles under the full scale development (FSD) contract, as budgeted for by NASA is estimated at $17.5 million. The unit cost, hardware only, for the IUS vehicles in the follow-on first production buy (of 4) is estimated at $55 million each in real year dollars.

(b) The projected unit cost in real year dollars, for hardware only, was estimated at $35-$40 million.

(c) The projection of the unit cost for the short, wide-body Centaur based on NASA/DOD studies is estimated in real year dollars, for hardware only, at $35-$40 million.

QUESTION M-30:

What are the projected development costs for the wide-body Centaur as compared to the short wide-body Centaur?

ANSWER M-30:

The development cost for the short wide-body Centaur programs has been estimated to be approximately $20 to $40 million more than for the long wide-body Centaur. Approximately $4 million is associated with redesign effort required for going from the long wide-body to the short wide-body configuration. The remainder of the $20- $40 million is additional estimated contingency requirements and additional DOD security and payload integration analysis.

QUESTION M 31:

How does the performance of the wide-body Centaur compare to that of the short wide-body Centaur?

ANSWER M-31:

For geosynchronous missions, the long wide-body Centaur could place a minimum of 13,000 pounds in orbit. The short wide-body Centaur would be capable of approximately 10,600 pounds to geosynchronous orbit. Relative to the Galileo mission, the wide-body Centaur could provide sufficient injection energy for a direct trajectory, however, the short wide-body Centaur injection energy is about 65 percent as great and therefore, the mission would have to be performed on an indirect or delta velocity-earth gravity assist trajectory taking about two years longer to arrive at Jupiter.

QUESTION M-32:

How does the IUS and short wide-body Centaur performance compare for Galileo and ISPM?

ANSWER M-32:

With an IUS, a third stage or kickstage has to be added in order to perform both missions. For Galileo the injection energy of the IUS 2-stage plus kickstage is approximately 55 percent of that of the short wide-body

Centaur. Both the IUS and the short wide-body Centaur will require the mission to be flown in an indirect or delta velocity-Earth gravity assist trajectory. The primary scientific objectives can be accomplished with either upper stage since the probe will be launched to the planet in either case. Because of the lower IUS energy the number of encounters to be made with the Jupiter moons will be less than with the short wide-body Centaur.

QUESTION M-33:

Did the Solar Maximum Mission retrieval plan submitted in the December Reprogramming of $35 million in FY 1982 include funds for the OMS Payload Bay Kit?

ANSWER M-33:

Yes.

QUESTION M-34:

When does NASA plan to resubmit this reprogramming request?

ANSWER M-34:

The notification of the proposed reprogramming was submitted on February 22, 1982.

QUESTION M-35:

We understand that NASA plans to propose a direct ascent mode for the Solar Maximum Mission retrieval.

(a) What are the FY 1982, FY 1983 and total funding requirements for this approach?

ANSWER M-35:

The FY 1982 and FY 1983 funding requirements are $18.2 million and $23.7 million respectively. Total funding, including FY 1984, is expected to lie in the range of $45 to $55 million.

QUESTION M-36:

Do you consider conducting this mission higher priority than longlead for the 5th Orbiter?

ANSWER M-36:

The Solar Maximum Repair Mission and the long-lead items for the 5th Orbiter do not lend themselves to relative prioritization, each contributing in its own way to different vital aspects of the STS program.

The Solar Maximum Repair Mission fulfills a clear need to demonstrate spacecraft retrieval for on-orbit repair/maintenance or for return to Earth. This would offer proof of feasibility and cost-effectiveness of the technique to mission designers with programs which could benefit. The experience gained will also be vital for missions already planned, such as Space Telescope maintenance and refurbishment missions, where it is essential to long-term spacecraft use.

Neither FY 1982 nor FY 1983 funds for the fifth orbiter have been included in the FY 1983 budget request. We believe a fifth Orbiter would provide additional assurance, principally to STS users. The timing of the funding requirements will be discussed with the Administration later this year.

QUESTION M-37:

What have you learned from STS-1 and STS-2 on the ability to retrieve and reuse the SRB's?

(a) What have been the problems?

(b) Have the costs and schedules been in line with what was expected?

ANSWER M-37:

(a) In the STS-1 retrieval operations there were problems in using the remote dewatering system. The boosters were successfully retrieved by using a backup manual system. This proved to be adequate and has been baselined for future retrieval operations.

The most significant problems in STS-1 and STS-2 were damage to the aft skirts (including thrust vector control systems) during reentry and water impact. However, these items are repairable.

(b) The problems with the aft skirts have not impacted the launch schedules since new aft skirts are scheduled for the first six flights. In order to reuse these components, we have had to expend more funds than originally planned. The repairs will incorporate design modifications to minimize future damage and costs associated with refurbishment.

QUESTION M-38:

(a) When is the performance improvement associated with the filament wound case development needed?

(b) Has this launch date been slipping? For what reason do you believe the launch date is now firm?

(c) We understand the need for the performance improvement comes in part from overly conservative weight margins being carried for both the Orbiter and the payload. Would you comment?

(d) Have you considered removing equipment from the Orbiter to provide the necessary payload capability?

ANSWER M-38:

(a) The performance improvement associated with the filament wound case will be needed for an October 1985 mission launched from the Vandenberg launch site.

(b) This launch date has not been slipping. However, it should be noted that this date is a stand-by date with an assessed low need probability to replace a presently operating payload. However, all NASA and Air Force budgets consistently support this date. If the stand-by launch is needed, it will be a very high national priority. The Department of Defense has reaffirmed their requirement for October 1985 to NASA and to the Office of Management and Budget as recently as December 1981 in a meeting at OMB. They restated that the October 1985 date constitutes a firm requirement and that the performance critical mission which may be required to be flown on that date cannot be accomplished without the performance improvement provided by the use of the filament wound case.

(c) Including the performance gained by using the Filament Wound Case SRB, the weight margins being carried for the October 1985 mission are prudent and necessary but are not overly conservative. They are the same margins as are carried for all other STS flights and they apply to more than just the Orbiter and the payload.

A 2,000 pound DDT&E reserve is carried to offset inert weight growth and performance shortfalls which may occur in the three and one-half years remaining before flight. This reserve applies to the entire STS system which weighs on the order of 330,000 pounds at the point in flight when the main engines are cutoff (MECO). This reserve, therefore, is only six tenths of one percent of the total injected weight at MECO and is indeed a very small margin.

Also, a 3,000 pound reserve is held until the beginning of the final detailed phase of flight planning for each STS mission, the Cargo Integration Review, which occurs approximately 18 months prior to flight. Beginning at

that time, this reserve is used to offset unexpected changes resulting from the detailed planning and includes such items as: payload accommodation equipment, ballast requirements to maintain flight control tolerances, refined requirements for duration, abort modes, and so forth.

(d) Yes, NASA has studied the removal of several fuel cell cryogenic reactant storage tanks and one pair of active thermal control radiator panel segments which may not be required for a specific mission profile but such measures are costly in terms of dollars and schedule time (to perform the removal and reinstallation tasks on the Orbiter) and the increased weight carrying capability resulting from the removal of these subsystems is not nearly adequate to meet the requirements for October 1985.

QUESTION M-39:

At the Kennedy Space Center we heard about plans to move forward with conducting a competition for a Shuttle Processing Contractor.

(a) Has the agency made a firm decision to move forward with such a competition?

(b) What would be the timing of such a competition?

ANSWER M-39:

(a) NASA is presently evaluating this competition. A group of potential contractors are in a formal assessment period, associated with the STS-3 launch activity. Their assessments along with our own evaluation will be considered in a final decision to proceed with this competition.

(b) A Statement of Work is presently being developed and will be completed so that a Request for Proposals (RFP) could be issued as early as May 1982. This could allow proposals to be received in late 1982 and a selection in the Spring of 1983. However, the decision to proceed is still pending.

QUESTION M-40:

What companies are observing the launch processing for the third flight?

ANSWER M-40:

Boeing Services International, Inc.
General Dynamics, Convair Division
Grumman Aerospace Corporation
Martin Marietta Aerospace
Rockwell International
United Airlines
United Space Boosters, Inc.

QUESTION M-41:

Could you elaborate on what you are doing to increase productivity particularly with regard to contract incentives?

ANSWER M-41

We are currently in the process of developing and implementing contract incentives which motivate both the contractor and the government to control contract costs in such a manner as to reduce the total cost to the government. Incentive features are being developed for our cost plus contracts which will positively incentivize our contractors to reduce costs. These incentives can be made a part of the contractors' business planning, can be fairly negotiated with the government, and are achievable.

We are now in the final stages of negotiating these incentives for two contracts: the external tank with Martin Marietta; and the solid rocket motor with Thiokol. In addition, the request for proposal for the development of the filament wound case will contain award fee and incentive fee provisions coupled with a provision for a not-to-exceed price.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE FEBRUARY 10, 1982 HEARING

QUESTION M-1:

Does the current stated development and recurring vehicle cost for the Centaur include the cost of meeting the DOD requirements?

ANSWER M-1:

The stated cost in the February 10, 1982 testimony was given for the long wide-body Centaur as configured for the NASA planetary missions and as such, did not include costs that might be necessary for DOD requirements.

QUESTION M-2:

The IUS has been designed with high levels of redundancy, reliability, and flexibility to handle mission contingencies from the Shuttle to protect against mission losses. Will the Centaur have a similar capability?

ANSWER M-2:

The Centaur avionics design does not have the degree of redundancy designed into the IUS and does not use high reliability (73-2C) parts. However, this is acceptable to NASA because the Centaur has demonstrated a high degree of reliability over a wide range of operational missions in the expendable launch vehicle configuration.

The Centaur has several capabilities such as multiple burn capability, variable thrust, and high payload lift which, although not required to meet current requirements, may be desirable for future missions.

The ability for test and checkout prior to deployment from the orbiter and restow capability is being designed into the Centaur system similar to the IUS system. In the case of a failure during pre-launch checkout from the Shuttle in orbit, the Centaur could be restowed, the doors closed, and the tanks dumped.

QUESTION M-3:

Does the stated development cost for the Centaur include the costs for modification of the orbiter and KSC ground facilities? How much would this additional cost be?

ANSWER M-3:

No. An additional $110-$125 million is required to modify two orbiters and one launch complex.

QUESTION M-4:

How do you reconcile the differences in then-year dollars in development cost of Centaur between the February 10 letter signed by Mr. Weeks quoting $230 million and the Upper Stage Alternatives study of October 1981 quoting $460 million plus $120 million to meet DOD requirements, in FY 1981 dollars?

ANSWER M-4:

The $460 million October 1981 estimate included the total FY 1981 dollars required for Centaur development, production and launch of two vehicles for Galileo and International Solar Polar Mission (ISPM) and the associated initial cost of production setup, ground support equipment, airborne support equipment, orbiter modifications and payload integration, etc. It was presented this way for use in the life cycle cost analysis as it was analogous to the IUS Full Scale Development (FSD) information available at that time. The February 10 letter provides insight for comparison with the IUS currently available development costs. The $230 million quoted in Mr. Weeks' letter was for only the Centaur development costs provided to the Air Force in July 1981 to be included (after change to FY 1981 dollars) as part of the $460 million figure and for performance of the life cycle cost analysis.

The table on page 78, comparing option 4A and 4B, indicates a delta of $120 million to meet DOD requirements assuming a short wide-body Centaur was already available. The $120 million was essentially associated with incorporation of redundant avionics systems, 73-2C parts, and associated/similar capabilities to the IUS systems such as a soft mount or cradle (load alleviation device), and some additional overhead cost for Air Force systems engineering effort.

QUESTION M-5:

What would be the delta development and recurring vehicle costs of Centaur if it were configured to meet all the requirements the IUS was designed to meet, i.e., redundant avionics, 73-2C parts, Mil-Std-1540 testing, etc.?

ANSWER M-5:

The Air Force indicated in the October study that additional development cost including a soft mount or cradle (load alleviation device) was estimated at $120 million. The added recurring cost per vehicle with redundant avionics similar to the IUS is estimated to be around $16 million (1981 dollars). The Air Force requirements may have changed since the October study and should be confirmed by the Air Force.

QUESTION M-6:

What would be the schedule of modification to the Space Shuttle for the Centaur? What loss of flight rate would occur due to this downtime and what would be the cost impact?

ANSWER M-6:

Structural modifications would be required in order to accommodate Centaur in orbiter vehicles OV-099 and OV-104. Modifications to OV-099 were planned to have been delivered as a mod kit and installed at KSC. The time for installation is assessed to be seven weeks. These modifications would be accomplished between flights on a noninterference basis to minimize impact to the flight rate. Modifications to OV-104 would be accomplished in-line at the Rockwell International/Palmdale manufacturing facility. OV-103 would primarily be for VAFB usage and therefore would not be planned to be modified at this time.

QUESTION M-7:

Considering that NASA and DOD requirements must be documented and released prior to approval and go-ahead of a sole source procurement for a short Centaur development, isn't it unrealistic to assume a schedule of less than 30 months for complete systems qualification and delivery of a flight vehicle and its highly complex support equipment?

ANSWER M-7:

Thirty months is an unrealistic schedule for delivery of a flight vehicle system. However, letter contracts for the Centaur development have been in effect since May 26, 1981, shortening the normal procurement cycle. If NASA were directed now to procure Centaur for use on Galileo, a September 1985 launch would be attainable, however it would be more reasonable to launch Galileo in May 1986 to shorten the trip time.

QUESTION M-8:

It is true that a number of spacecraft (TDRS, DSCS, DSP) are well along in their design and integration on IUS and will be impacted by this switch to Centaur. Are these cost impacts included and how much do they amount to?

ANSWER M-8:

The cost impacts of changing existing spacecraft to be compatible with Centaur are not included and could be substantial. However, such a change would not need to be made unless the IUS were not available. Otherwise, if it is less expensive to fly a currently designed spacecraft on the IUS, it will be flown on that vehicle. No cost impacts have been included as the spacecraft which were planned to be flown on the Centaur were the Galileo and ISPM planetary missions as well as future spacecraft in the predevelopment or early development phases.

QUESTION M-9:

Isn't liquid hydrogen contained in pressure stabilized common bulkhead tanks a significant safety risk for a man-rated orbiter? Doesn't the Centaur have a history of propellant leakage?

ANSWER M-9:

After several years of detailed evaluation, NASA is convinced that the Centaur pressure stabilized tank design does not present any significant safety risks for the orbiter.

The Centaur does not have a history of propellant leakage. A total of 64 Centaurs have been flown with only one flight failure wherein a propellant leak was even remotely suspected as the possible cause.

QUESTION M-10:

A risk assessment of the short Centaur was made jointly by the Aerospace Corporation and the Air Force in coordination with NASA Lewis Research Center. What were the risks and concerns raised as a result of this assessment?

ANSWER M-10:

The Air Force with the Aerospace Corporation did do a risk assessment. The results were discussed with NASA representatives at the Space Division (SD) in mid-January. The discussion revealed that the assessment, although it raised some good questions, was preliminary and reflected concerns more typical of DOD requirements. For example, the Centaur avionics systems were considered a high reliability risk. Since the Centaur avionics system was upgraded in the early 1970s, the Centaur has flow 37 consecutive missions without an avionics failure. Software was also considered a risk as well as the LH_2 and LO_2 tanks (see answer to Question 2).

As a result of a two-day DOD/NASA session, some of the concerns previously expressed were resolved. For example, software validation was no longer a concern when it was understood that LeRC validates the software programs developed by the contractor, which is an approach similar to the one the Air Force uses, i.e., a contract with the Martin Company validates the software developed by the Boeing Company for the IUS. However, the comparison of the theoretical reliability of the yet unflown IUS redundant avionics systems with the theoretical reliability of the flight proven (37 consecutive flights/100 percent reliability of existing system) single string Centaur avionics system was a concern. It is true that NASA intends some minor modifications to the avionics system. The modifications by existing vendors are not considered by NASA significant in terms of reliability risks but are considered a risk by some programs in DOD.

A final review of the Centaur concerns are as follows:

1. Schedule: Only 41 months remain between now and the planned September 1985 launch date for Galileo. To fly both Galileo and ISPM in the same year (Spring of 1986) would require modifying a second launch PAD.

2. Security: The Air Force was concerned about the security aspects of the Centaur systems. Discussion with the contractor and LeRC revealed that the Centaur avionics hardware and software appear readily adaptable to modifications required to meet security requirements.

3. Spacecraft Loads Impacts: The Air Force considered this area as possibly the greatest risk as the impact to already existing spacecraft were considered unknown as load analysis programs have not yet been run. NASA realizes that a cost risk is involved; however, if a load alleviation requirement does develop, the design and development of the support structure for use in the orbiter cargo bay can be changed accordingly. NASA did incorporate $20 million into cost analysis in January for a load alleviation device should it be needed.

4. The risk of NASA management for vehicle development with expected emphasis on NASA priorities was an expressed concern. This should not be a concern if the program had appropriate joint guidance at higher management levels. An Air Force deputy manager role was discussed along with utilization of Air Force officers at LeRC in various positions during the development phase.

In summary, the final risk concerns appear to have been reduced to the four discussed above.

QUESTION M-11:

Do the quoted costs for the Centaur program include the costs associated with tests, such as system, structural and environmental, that are normally associated with space vehicle development requirements? What are the risks in eliminating these?

ANSWER M-11:

The quoted costs for the Centaur program include those costs associated with design and development testing. The postulated Integrated Test Plan for Shuttle/Centaur includes approximately 20 major structural/loads tests, 43 major system/integration tests, and 30 major environmental tests. These are in addition to subsystem and component design and evaluation tests that would need to be performed.

QUESTION M-12:

Although it has been stated that for Centaur you could use a significant percentage of off-the-shelf hardware, isn't it true that these components will be exposed to yet to be defined environments which will require substantial if not total requalification at both the component and subsystem level?

ANSWER M-12:

If NASA were directed to proceed with Centaur for NASA missions, every attempt would be made to preserve the integrity of the Centaur flight systems to the greatest extent possible. Therefore,

modifications to the major vehicle subsystem would be made mainly to fulfill Shuttle safety requirements:

1. The propulsion (RL-10) subsystem would be modified only to provide pre-valves in the LOX and hydrogen systems. The new valves would be of the same design as valves presently used on the Centaur D-1A.

2. The propellant tank pressurization system would be modified only by the addition of two transducers in each propellant tank to provide additional redundancy over the present three-transducer configuration and by the addition of valves in the pressurization supply to provide redundancy against overpressurization.

The environment in the Shuttle is not significantly worse than Atlas Centaur. However, requalification would be accomplished where necessary.

Mr. FLIPPO. Thank you. I believe we would like to take Dr. Weiss' testimony and then have questions if that is acceptable with you.

Doctor, it is a pleasure to have you with us. Please proceed as you deem appropriate.

Dr. WEISS. Good morning, Mr. Chairman, and members of the committee. I am pleased to be here again, especially after the development status of the Space Shuttle as described by General Abrahamson; and, the light that this casts on our future in the space transportation business as we move on into what will be a greatly expanded era of the use of space as a resource.

With your approval, I would like to enter my full testimony.

Mr. FLIPPO. Without objection.

Dr. WEISS. I would like to provide, at this time, a summary of what I consider the salient points. I am very pleased to discuss the activities of the Office of Space Transportation Operations and its fiscal year 1983 budget request which provides funding for the program within the fiscal constraints we are all operating under during this difficult period.

As you may recall, the responsibilities of my office are to manage and coordinate the U.S. civil launch capabilities, and to cooperate with the Department of Defense in providing launch services for national defense missions. In addition, the development of launch agreements, our contracts with the users, we are responsible for the formulation of policies for users of the national space transportation system, which will consist of the operational fleet of Space Shuttles and a stable of proven expendable launch vehicles, which we generally refer to as our ELV's. These policies include the Shuttle and ELV pricing, pricing for Spacelab, self-contained payloads, use of the middeck, and other usages of the Shuttle. The responsibility for marketing and scheduling the launch services of the entire space transportation system is also ours.

We are the NASA office responsible for the Spacelab development, as performed by the European Space Agency, and of course, the event of the delivery of the first unit was of great importance to us and we are pleased some of you were able to be there for the acceptance ceremony last week.

With these responsibilities, our goals are maintaining the U.S. position as a world leader in space activities by providing space transportation on a routine, assured basis and also in supporting advanced and new applications for the use of space. We also provide space support services for the DOD, other Government users and industrial and scientific applications. Looking toward the application of the Shuttle itself, we plan 28 operational missions through 1985. That is, added to the four orbital flight test (OFT) flights, a total of 32 flights, as described earlier.

We expect to maintain a Space Shuttle price which recovers reasonable costs, but also is competitive. We are operating in a competitive environment, as Mr. Beggs commented yesterday, and that is an important aspect to the way we conduct our business. We expect to obtain maximum benefits from the U.S. investment in the Shuttle through a broadened usage. Commercial business operations for our office grew considerably in the last year as national space operations moved into a truly mixed fleet. In fact, we are now utilizing a mix of expendable launch vehicles and Shuttle ca-

pabilities in package offering to satisfy the scheduling requirements of commercial satellite users. For example, we have very recently proposed to Brazil a combination of a Delta launch early in 1985 and a Shuttle launch in late 1985 and one in 1986 in order to satisfy their schedule requirements. We were not able to accommodate them solely on the Shuttle, which they desired because of the cost benefits in using the Shuttle. We were able, however, to provide this schedule capability, along with an average price lower than that which they would have had using only the Delta launch vehicle, or for that matter, going to Ariane as a competitive opportunity.

Now, this business is pretty well characterized by some of our 1981 activities. We had 11 successful expendable launch vehicle missions (chart A). Two were for NASA missions. The other nine were fully reimbursable with one for the Department of Defense and the others for commercial communications satellites. We had the first two flights of the PAM, the payload assist module, which is vital to our Shuttle usage for communications satellites because it is the booster rocket which is used for communications satellites after deployment from a Shuttle in order to reach geosynchronous orbit.

It is also used as the final upper staging for the Delta rocket. We had some concern about the PAM because of a test failure which caused a redesign of the manufacturing process for the nozzle on this motor. In addition, DOD is funding additional testing to support their use of the PAM, which will give our Shuttle users added confidence. The first Spacelab flight unit was delivered. We think that ceremony had benefits besides simply commemorating the instance. It gave an opportunity for the administration's statement of strong support for our NASA activities and our space policy by Vice President Bush.

The first operational mission for the Spacelab element also took place this year. The OSTA payload, an Earth resource payload on the last mission, used an engineering model pallet of the Spacelab design. The scientific space pallet which we will be using on the next mission also uses that hardware. Those pallets represent the first contribution of European hardware in a flight of our Space Shuttle system. This is the flight module chart B that was delivered to KSC last month and provides the shirt-sleeve environment to which we look to provide a new level of capability for operating in space.

You are looking at the left-hand of the side the synthetic aperture radar antenna and the packages that are located on the OSTA payload pallet (chart C).

In 1981, we picked up in our bookings with 41 additional reimbursable payloads scheduled both on the ELV's and on the Shuttle. While this number appears large, it has a very even distribution through the coming years which is indicative of the very steady character of our business.

Mr. FLIPPO. Dr. Weiss, there are those who maintain there is not much demand for the Shuttle. What do you reply to that?

Dr. WEISS. The demand for the Shuttle now exceeds our capability of providing launch services with it alone.

Mr. FLIPPO. What percentage of that is Government payload as opposed to non-Government payload?

Dr. WEISS. I would like to reserve my comment on that, Mr. Chairman, until I show you the schedule, and you can get a good idea of what we are doing.

Mr. FLIPPO. Very good.

Dr. WEISS. In the development of the business and satisfying demand, we require earnest money from our users, which is a $100,000 nonrefundable deposit, but one which can be applied against the price of flying on the Shuttle. We then proceed from that phase to the establishment of our contracts for flight, the launch service agreements. We have stepped up our activity considerably in the past year with five signings and look toward a good number more this year. In addition, 28 small self-contained payloads were booked and we had some 30 launch service agreements. We really have had a remarkable response from a very broad variety of new adventures or venturers in space using the small self-contained payload, which I will mention a little later.

The heavy portion of funding required in the Operations program now moves toward the supply of the tanks, solid rocket boosters, and the support for missions. In 1981, this transition was initiated with some 10 external tanks and 4 sets of solid rocket boosters in process.

In 1982, we are pursuing the same character of activity, extending our bookings and expanding the development of capabilities, both in terms of our facilities as well as the hardware in process to satisfy the downstream Shuttle missions. We will be taking delivery of the second element of the Spacelab this May. Our follow-on procurement will be going into its final stages. We have a major activity with the Europeans in their supply of a second full Spacelab system. In the Expendable Launch Vehicles area, this year alone, we have 13 launches planned. These involve some seven Deltas, three Centaurs, one Atlas which will be furnished by the Department of Defense for a NOAA payload which we have responsibility for launching, and two Scout vehicles.

Since fiscal year 1983 is the start of operational commercial use of the Shuttle, I would like to review the near-term schedule (chart D) for the space transportation fleet activity in the next 5 years. This chart addresses your earlier question, Mr. Chairman. With the Space Shuttle, our commercial and foreign usage is second only to the NASA usage. If you were to remove the Tracking and Data Relay Satellite from the NASA group of missions, you would find that through 1986 there are 14 commercial and foreign missions, 14 NASA missions and 12 planned DOD missions. Our expectations of DOD usage have been modified recently by their requirement for meeting earlier schedules for some of their missions, satellite replacement and other considerations. Therefore, the percentage of utilization has dropped; however, we haven't been disappointed. We are able to fill every space we have and we would be happy to have another orbiter available if it were possible.

Mr. FLIPPO. Do you have any idea how many U.S. companies are signed on with the Ariane?

Dr. WEISS. The number of companies probably is in the order of six or seven. The bulk of the missions we look on as backup mis-

sions, Ariane, in turn, looks on us as backup for these missions. On a firm basis, we do have a number of signings, and we expect that, for instance, Southern Pacific Communications will, indeed, fly on Ariane. We were not able to accommodate them on the Shuttle when we had hoped and that the price offered by Ariane was substantially lower than was achievable with our Delta class vehicle. The payment schedule had a large measure of importance in this case as well.

Mr. FLIPPO. You and Ariane are both counting the same flights? Sounds like double accounting, does it not?

Dr. WEISS. Chart E will show some elements of the double accounting that takes place. It is clear our traffic model is not the item that governs the extent of our business. Right now, it is capability. That is a good position to be when you are initiating a business of this sort. This not only emphasizes the growth of the communications satellite business, which is the key to the competitive aspect, but also the demand that has given rise to this competition. It has also extended the use of our own expendable launch vehicles, and we are assuring that that continuity to meet the demand not yet fillable by the Shuttle. The body of customers involved is seen in the next chart.

The concentration is not just in U.S. companies at all but in the expansion of communications satellites as an element of national investment all around the world. This chart shows those companies with satellites that are booked on both Shuttle and expendable launch vehicle either for backup reasons, or because of earlier launch needs than we could supply on Shuttle.

I just wanted to address briefly the expendable launch vehicle schedule which emphasizes this demand (chart D). The commercial and foreign area forms the largest portion of the use of our expendable launch vehicle. The bulk of this lies with the Delta vehicle and the Intelsat communications satellites which are to be launched this year and in 1984 on the Atlas Centaur. The DOD set of numbers is largely the Scout vehicle which launches the follow-on to the transit satellite for the Navy and for some Air Force experimental systems. There are also three FLTSATCOM missions scheduled for the Atlas Centaur as well.

Mr. WINN. Doctor, are you going to speak to the NOAA satellite issue now or later?

Dr. WEISS. I wasn't specifically. I will be happy to answer questions on it.

Mr. WINN. I just wondered, what are they doing? What is the gist of some of the things they are putting up?

Dr. WEISS. NOAA, of course, continues its weather monitoring systems. We will be putting up our Landsat systems for which the data will be worked through NOAA. These will be put up on a single basis rather than on a global network as previously explained. Our launches for NOAA run on the order of two per year, dedicated largely to the weather systems.

I wanted to give some credit to our get-away specials (chart F). The first flight of this class of payload will be launched with STS-4, courtesy of General Abrahamson's OFT flights. On the STS-3, we will be proof testing the container that carries these experiments. As you can see, the number has grown. It stood around the

290 to 300 level last year; but, it's starting to grow again, with an increase in industrial participation. That, of course, is something we are very pleased with because the industrialization of space is one of the major areas for space transportation. We are developing a bridge structure which will permit us to carry more of these payloads at one time than would be possible with the attachments we now have. So, we would hope to provide the user of "get-away specials," which fly on a space available basis, a much greater opportunity than previously planned.

I wanted to discuss briefly our 1983 planned activities, and we will tie this to our budget plan. As our schedule noted, 1983 is a very active and exciting year. Our budget, while tighty drawn, should be adequate to cover the activities planned. These activities lie in the area of Shuttle operations where the launch of five Shuttles in 1983 is the most significant note. But, the preparation for the launches downstream is just as vital to us. Some of that preparation is the procurement of IUS's to launch the tracking and data relay satellites to provide payload support operations for about 33 NASA payloads that will be launched through 1986. The number of payloads never matches the number of missions. That, of course, is because the Shuttle is capable of carrying many more than single payloads. When we speak of multiple NASA payloads, we are speaking generally of pallets along with other deployable missions. Major missions receiving support in fiscal year 1983 will include Galileo, TDRSS, Spacelab-1 and -2, and, of course, the Space Telescope, which will fly in 1985.

Another significant activity we are planning is the on-orbit repair of the disabled solar maximum mission satellite using the Space Shuttle in fiscal year 1984. Our primary mission is to conduct technical demonstration of the Space Shuttle capability for on-orbit rendezvous, retrieval, repair, checkout, and deployment of a free flyer spacecraft. This gains valuable science as well with the solar Maximum mission because its reuse will give another couple of years of very important data relative to the Sun. We consider this mission to be a vital opportunity to demonstrate Space Shuttle rendezvous and retrieval capability which will be necessary for a variety of missions. Of particular interest from a NASA standpoint, is the application to the Space Telescope. Of course, we would anticipate other usage both by NASA and the Department of Defense. At the same time, this mission will also demonstrate multiple capabilities of the Shuttle by carrying into orbit and deploying the long duration exposure facility, a 20,000-pound payload which has about 70 experiments and also provides the heaviest exercise for the Remote Manipulator Arm that we will have had to date. This mission will be in late fiscal year 1983, early fiscal year 1984 and a very important element in preparation for usage of the Space Telescope mission.

General Abrahamson showed those aspects that fall within his jurisdiction in terms of the space transportation budget. I have done the same here (chart G). There is one overlap in the operations capability development area, where some of the development support for the upper stage remains as D.D.T. & E. activity. In addition to this, the operations funding provides the establishment of multiple mission payload equipment; that is, reusable equipment

such as wiring harness which will provide us the capability of supporting multiple payloads downstream. Upgrading of the Mission Control Center is an important aspect of this budget line. I might note that there is an upgrading or modification going on for security reasons to support the Department of Defense. This program is totally funded by the Department of Defense; there is no NASA funding involved. We also are providing in this budget line payload integration checkout for the pallets carried on the OFT missions, for the Payload Operations Control Center that we initiated, very successfully, with the last mission, and for the studies on improvements of both system activities and operations of the space transportation business in our operations effectiveness area.

For Spacelab, which is heading toward its first launch, the major funds are applied to preparations for launch procurement of the second Spacelab unit, which takes about half of the funds and which we expect to obligate in 1983, is also included as well as funding for the maintenance and repair capability implementation, integration of flight hardware, and continuing procurement of initial spares. In the launch vehicle area you will note a very small line, that is, the $42 million. You have to recognize that this is in fact a $250 million business when you add in the reimbursements we receive from all of the users. We have a very substantial business activity going there as we proceed with the procurement of the Deltas, the Atlas Centaurs, and the Scouts. However, the noted funds are for two NASA missions, Landsat-D, and the Solar Mesospheric explorer mission in 1984.

Mr. FLIPPO. Doctor, would you refresh us on the current policy of how you handle these reimbursables. Those funds, do they stay within the Agency or do they go straight to the Treasury, or what?

Dr. WEISS. They go directly to the procurement and activities involved in the supply of the expendable launch vehicles and in supporting the integration of payloads and carrying out of the missions.

Mr. FLIPPO. NASA retains those funds?

Dr. WEISS. Yes, NASA retains most of those funds. I believe that we retain the funds. Is that correct?

Mr. KRATOVIL. The funds we receive from reimbursable customers are deposited to a NASA account in the U.S. Treasury. A small use fee, approximately $200,000 for a Delta, is retained by the Treasury.

Dr. WEISS. We receive these funds not in a lump sum for each mission. They are provided to us on a progress payment basis over a 30-month period for the expendable launch vehicles. With the Shuttle, our reimbursements are received on a 33-month period.

I believe we are planning a very ambitious program for Fiscal Year 1983. I think that is the case for the entire. From our standpoint, this includes operational Space Shuttle missions, first flight of Spacelab just beyond that time, and continuation of the expendable launch vehicle operations. We are looking forward to achieving these goals, and we believe that the space transportation system being put in place for the Nation will be a credit to the Nation and to the people who supported it. Thank you.

[The prepared statement, plus answers to questions asked of Dr. Weiss, follow:]

STATEMENT

of

DR. STANLEY I. WEISS

ASSOCIATE ADMINISTRATOR FOR
SPACE TRANSPORTATION OPERATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I welcome this opportunity to meet with you to discuss the activities of the Office of Space Transportation Operations (OSTO) and to present our portion of the NASA FY 1983 budget request. Our budget request provides funding for the OSTO program for FY 1983 within the fiscal constraints of the President's economic recovery program.

The major accomplishments of the Office of Space Transportation Operations in 1981 included the delivery of the first Spacelab flight unit to the Kennedy Space Center (KSC), the first operational use of a Spacelab instrument pallet on STS-2 and a perfect record of successful missions using Expendable Launch Vehicles (ELV's) for NASA and reimbursable users. Another first was the use of the McDonnell Douglas Payload Assist Module or PAM-D in launching communications satellites. The OSTA-1 and OSS-1 payloads and the Small Self-Contained Payload (Getaway Special) verification flight unit were delivered to KSC during 1981.

FY 1983 BUDGET REQUEST

INTRODUCTION

This year marks the beginning of the Space Shuttle operational era and for the FY 1983 budget the Office of Space Transportation Operations is requesting $1623.5M, which represents an increase of $912.4M over the amended FY 1982 budget. These funds, together with reimbursements for launch services from non-NASA users, will provide for five operational Shuttle missions in FY 1983 and also support the long-lead procurement of external tanks, solid rocket boosters, spares and other equipment necessary for operational missions in FY 1984 and beyond. In addition, funds are requested for the first Spacelab mission as well as procurement of the second Spacelab flight unit and spares from the European Space Agency. Finally, funds are also required to maintain procurement of Expendable Launch Vehicles (ELV's) to support NASA scientific missions. A large part of the budget increase represents a transfer of funds for launch and mission operations, which almost entirely supported the Orbital Flight Test Program prior to this year, from the Design, Development, Test and Evaluation (DDT&E) elements in the Office of Space Transportation Systems to our operations budget which directly supports all subsequent operational missions.

The FY 1983 request includes two major budget line items for the Office of Space Transportation Operations. The Space Flight Operations budget line item for FY 1983 is $1707.0M of which $1580.7 is the Office of Space Transportation Operations responsibility. This budget line item includes items totaling $126.3M which are defined and supported in the testimony of the Office of Space Transportation Systems. The Expendable Launch Vehicles budget line item for FY 1983 is $42.8M.

Before I present our budget request in more detail, I would like to discuss the responsibilities, business operations and goals of our office.

RESPONSIBILITIES

It is the responsibility of the Office of Space Transportation Operations (OSTO) to manage and coordinate U.S. civil launch capabilities and to cooperate with the Department of Defense (DOD) in providing launch services for national defense missions. OSTO is responsible for the formulation of policies for users of the National Space Transportation System (NSTS) which will consist of the operational fleet of Space Shuttles and a stable of proven Expendable Launch Vehicles (ELV's). These policies include Shuttle and ELV pricing, development of Launch Services Agreements (LSA's) and pricing for the Spacelab and our Small Self-Contained Payload (Getaway Special) program. In addition, we are responsible for marketing the launch services of the NSTS and for the promotion of improvements in the system to reduce costs and meet growth in users' requirements. We are also the NASA office responsible for the Spacelab development performed by the European Space Agency (ESA) and for its operation as an element of the Space Transportation System.

COMMERCIAL USERS

Commercial business operations for our office grew considerably during the past year. New major users included six U.S. commercial and six foreign customers for a total of 41 new reimbursable payloads. An additional 28 new Getaway Special payloads have also been booked for Space Shuttle flights.

During the past year we signed four major Launch Services Agreements; one with Messerschmitt-Boelkow-Blohm (MBB) of West Germany for a Shuttle launch and three ELV Launch Services Agreements with AT&T, Western Union and RCA. Two more Shuttle LSA's are ready for signature with Telesat of Canada and Deutsche Forschungs - und Versuchsanstalt fuer Luft - und Raumfahrt e V (DFVLR) of West Germany, and several ELV LSA's are also ready for signature. The first year LSA's were signed for the Small Self-Contained Payloads (Getaway Specials) was 1981, and this class of payload now accounts for 30 signed agreements with six more ready for signature.

Space transportation is indeed an expanding business and the Space Shuttle is not only an extension of the launch service business we currently operate with Expendable Launch Vehicles, but it extends the services possible both in launch and orbital operations modes. In fact, we are utilizing ELV and Shuttle capabilities and availability in package offerings to communications satellite users. For example, we have recently proposed a combination of a Delta launch in early 1985 and a Shuttle launch in 1986 to satisfy the schedule requirements for the Brazilian National Communications Satellite System (EMBRATEL).

COMPETITION

As with any business, when the market expands, so does the competition. Along with the U.S. and the USSR, the Japanese and European Space Agency now have the capability to provide launch services to Earth orbit. The USSR has launched experimental payloads for India but has not yet actively marketed its capability to provide launch services to reimbursable users. We have agreements with the Japanese which preclude them from providing launch services to third parties with their N and H rockets, developed with NASA assistance, unless they first acquire U.S. concurrence. However, they could sell or lease on-orbit satellite services for communications users. And, of course, competing directly with NASA for reimbursable payloads, the predominantly French Arianespace Company is actively marketing launch services with the ESA-developed Ariane rocket.

Ariane is approximately equivalent in performance to our Atlas-Centaur vehicle and can launch one Atlas-Centaur class or two Delta-class payloads. In addition to pricing their launch services below our ELV's, Arianespace is offering very favorable financing arrangements to prospective payload users -- three U.S. commercial users have already signed launch agreements to fly on that system. We are currently evaluating strategies to compete effectively with the Ariane, with both price and other capabilities of our Shuttle/ELV fleet being considerations. Our office is, of course, obligated to establish new prices for Shuttle launches beyond 1985 (governed by previously established policy), and we expect these to be competitive.

DOD RELATIONS

We are also in the business of providing launch services for DOD and are increasing our cooperative activities with them to support their mission requirements. These include payload integration and mission operations planning for several DOD payloads plus facility and procedural modifications at the Johnson Space Center (JSC) and the Kennedy Space Center (KSC) to provide for secure DOD payloads. The DOD is responsible for the development, activation and future operation of the Space Shuttle launch complex at Vandenberg Air Force Base in California. This capability is scheduled to be available in late 1985 for both DOD and NASA launches. We are also currently involved in the negotiation of a Memorandum of Agreement (MOA) with DOD which updates the STS reimbursement policy for Space Shuttle launch and associated services. Other cooperative efforts include NASA's utilization of the Air Force to supply the Inertial Upper Stage (IUS) for the Tracking and Data Relay Satellite (TDRS) and NASA planetary payloads and NASA's reliance on Air Force range support at KSC and the Western Space and Missile Center. DOD's recent decision to use elements of the Spacelab for certain orbital experiment programs and intention to fly several small payloads in our Getaway Special canisters on future Space Shuttle missions provide furtner evidence of the benefits of the Shuttle to national security needs.

GOALS

The Office of Space Transportation Operations' major goal is ' maintain the U.S. position as a world leader in space launch and orbital service activities through effective operation of the National Space Transportation System. Specifically, we will initiate operational Space Shuttle

missions with the flight of STS-5 early in FY 1983 and plan to conduct 28 operational Shuttle missions through 1985 following completion of the four Orbital Flight Tests this year. In response to increasing foreign competition for reimbursable launch services, we will pursue a Shuttle cost-per-flight reduction plan to permit competitive pricing while still recovering STS operational costs for the government. We will also be increasing our activities to stimulate the use of space as a resource and, therefore, broaden our market.

I would now like to discuss our budget request for FY 1983 and explain the details about anticipated costs in major areas of our program.

SPACE FLIGHT OPERATIONS

The FY 1983 request for the OSTO portion of Space Flight Operations of $1580.7M includes $1414.1M for STS Operations, $53.4M for STS Operations Capability Development and $113.2M for Spacelab.

SPACE TRANSPORTATION SYSTEM OPERATIONS

Space Transportation System (STS) Operations covers activities in Shuttle Operations, Spacelab Operations, Upper Stages Operations and Payload Support Operations. Funding for STS Operations will support a schedule of five launches in FY 1983, 10 launches in FY 1984 and 13 launches in FY 1985. Our FY 1983 budget request for STS Operations of $1414.1M, includes $1316.6M for Shuttle Operations, $63.0M for Upper Stages Operations and $34.5M for Payload Support Operations.

The successful Space Shuttle test flights of STS-1 and STS-2 have demonstrated the technical feasibility of our reusable Space Transportation System. With two remaining orbital flight test missions scheduled in 1982, we are on the threshold of routine manned access to space. Current plans are to fly two NASA payloads and eight reimbursable commercial payloads on five Space Shuttle flights in FY 1983. As we initiate the operational Space Shuttle phase, we will continue to develop our operations capability to support an increasing rate of missions. NASA's preparations for operating the STS on a full scale include all of the activities required to plan, schedule and conduct Space Shuttle operational missions. They include such elements as facilities, flight hardware, personnel, plans and operating procedures. In addition, we must provide and prepare ground and flight equipment, ground and flight crews, flight planning and mission control functions, computer support, communications links, logistics support, scheduling, user interface integration and overall management of the system.

In conjunction with the Office of Space Transportation Systems we are funding several activities designed to promote efficiency and economy in operating the Space Transportation System as we begin the operational period. The most significant of these activities is the NASA and contractor effort to improve the producibility of external tanks and solid rocket boosters, which are limiting factors in the capability of the Shuttle to support the level of 24 flights per year in FY 1988.

Another significant activity for which funding is included in the FY 1983 request is the on-orbit retrieval and repair of the disabled Solar Maximum Mission Satellite using the Space Shuttle in FY 1984. Our primary objective for this mission would be to conduct a technical demonstration of the Space Shuttle capability for on-orbit rendezvous, retrieval, repair, checkout and redeployment of a free-flyer spacecraft. In this mission two astronauts would leave the Orbiter in spacesuits to replace the attitude control system module on the spacecraft and perform other repairs. We consider this mission to be a vital opportunity to provide early demonstration of Space Shuttle rendezvous and retrieval capabilities which will be necessary for a variety of civil and national security missions, including the NASA Space Telescope.

Preparations for Shuttle Operations continue to require the largest portion of the OSTO budget. The $1316.6M requested will be used to support the first five operational Shuttle missions, procurement of long-lead equipment for future operational missions and sustaining engineering. These activities include mission planning and flight operations, orbiter launch and landing processing, cargo processing and payload integration and procurement of external tanks, solid rocket boosters and spare equipment. During FY 1983 we will have 18 external tanks in production with five delivered to KSC and nine solid rocket booster flight sets in production with five sets delivered to KSC.

FY 1983 funding for Upper Stages Operations is required for the production, delivery and operation of the Air Force Inertial Upper Stage (IUS). During 1983 we will use two IUS's to carry two Tracking and Data Relay Satellites (TDRS's) from the Shuttle to geosynchronous orbit.

FY 1983 funding for Payload Operations Support provides for continuing integration and analysis activities relating to NASA payloads scheduled for launch through FY 1987.

STS OPERATIONS CAPABILITY DEVELOPMENT

STS Operations Capability Development (OCD) includes Multi-Mission and Payload Support Equipment, Mission Control Center upgrading (MCC II), Payload and Operations Support and STS Operations Effectiveness. Our FY 1983 budget request for STS Operations Capability Development is $53.4M.

Our funding for Multi-Mission and Payload Support Equipment will be used to continue development, test and installation of a variety of flight and ground hardware which will be developed into a standard, reusable inventory of equipment to be used with a wide variety of payloads.

Our funding request for the continuation of Mission Control Center upgrading (MCC II) will be used to reconfigure the MCC at the Johnson Space Center with new equipment and software to support the requirements of the STS operational flight schedule. The DOD is also providing funds to install required modifications to support their unique mission requirements, including security.

Our funding request for Payload and Operations Support will be used for the development and activity of the Payload Operations Control Center (POCC) at the Johnson Space Center which will support NASA Spacelab missions in conjunction with the Mission Control Center. The funding for FY 1983 will be primarily for the Spacelab-1 and OSTA-2 missions.

FY 1983 funding for STS Operations Effectiveness will be used for initiating improvements in STS vehicle hardware, vehicle turnaround and cargo processing, mission operations and system software automation. This funding will also support Systems Planning and Effectiveness studies to develop marketing strategies for assuring maximum utilization of the National Space Transportation System (NSTS) while reducing the cost and complexity of STS Operations. It will also be applied to evaluating possible scenarios for the future institutionalization of the Space Transportation System.

SPACELAB

The Spacelab is a key element of the Space Transportation System. It is a versatile general purpose laboratory designed for manned and unmanned operation inside the Orbiter payload bay. It includes a pressurized module with a comfortable "shirt-sleeve" environment plus support pallets which carry experiments requiring direct exposure to space. Our FY 1983 budget request for Spacelab is $113.2M.

The first Spacelab flight unit is currently at the Kennedy Space Center (KSC) for the initiation of checkout and testing to support the first Spacelab mission in FY 1983. The engineering model (delivered December 1980) and three engineering model pallets are also being used for preflight tests and evaluations. We are looking forward to the first Spacelab mission in FY 1983 and are under contract to procure the second flight unit from ESA. Also, we are continuing to promote use of the Spacelab by reimbursable users and are currently scheduling Spacelab missions for the Germans (Spacelab D1 and D4) and payloads for the French and Japanese.

OSTA-1 was the first scientific payload to be flown on an ESA-developed Spacelab pallet in the Space Shuttle. The OSTA-1 mission demonstrated that the Orbiter is an excellent platform for conducting scientific investigations in Earth orbit. Although the flight of STS-2 was shortened from five to two and one half days, NASA scientists received high quality data from the Shuttle Imaging Radar and five other experiments, achieving 90 percent of the primary goals for this mission.

Most Spacelab funding will be used to continue the procurement of the second flight unit and spares for which we have contracted with the European Space Agency (ESA). It will also support the first Spacelab mission in late FY 1983 with completion of the first crew transfer tunnel and the Spacelab simulator which supports crew training at JSC for their mission. Funding will also be required for analytical and physical integration of Spacelab-1 as well as the continuation of sustaining engineering, logistics and testing efforts. Although the design of the ESA-developed Spacelab flight unit and ground support hardware is well-defined, some FY 1983 funding will be necessary to perform minor modifications to the Spacelab flight ground support equipment hardware, facilities and follow-on hardware at KSC to assure proper interfacing, compatibility and reliability. In addition, funds will be required for the Spacelab integration contractor to support preparations for the first flight, to test the new crew transfer tunnel, to maintain operational software using the Software Development Facility at the Marshall Space Flight Center, and to continue integration and checkout of the flight unit hardware and software at KSC.

EXPENDABLE LAUNCH VEHICLES

NASA's Expendable Launch Vehicle fleet continues to provide the largest number of U.S. launches and will total 13 in 1982. While NASA will fly Atlas-Centaur, Delta and Scout missions, all but two will be fully reimbursable by the commercial, foreign and other government agency users. Our FY 1983 request for this budget line is $42.8M.

The OSTO has maintained an active Expendable Launch Vehicle program to meet the space transportation demand for other U.S. government agencies, commercial and foreign users and the DOD, as well as NASA's own payloads not scheduled for launch on the Space Shuttle. During 1981, we successfully launched two NASA scientific and nine reimbursable payloads on NASA ELV's. The McDonnell Douglas Payload Assist Module (PAM-D) was successfully used for launching one RCA and two SBS communications satellites. A version of the PAM-D, called the Spinning Solid Upper Stage (SSUS-D), has been developed to be used with the Space Shuttle to launch U.S. and foreign commercial communications satellites. We have already scheduled six NASA and 50 reimbursable payloads to be launched on NASA ELV's through the end of FY 1985 to supplement the launch capability of the STS. We are continuing to maintain Delta rocket launch capability as a backup to the Space Shuttle and to meet heavy user launch demands as required during the build up of the STS to full operational capability.

Our FY 1983 funding for Expendable Launch Vehicles will be used primarily for the Delta launch vehicle to support NASA missions scheduled for launch in this and subsequent years. These missions include the Infrared Astronomy Satellite and Landsat-D^1 to be launched from the Western Space and Missile Center and the Active Magnetospheric Particle Tracer Explorer to be launched from the Eastern Space and Missile Center. The funding is required for the continuation of hardware production, technical and engineering support to sustain vehicle test and checkout and launch operations at both sites.

The major funding requirements for the ELV program are not reflected in this request. That funding comes from reimbursable users of NASA ELV launch services. These include DOD for communications and navigation systems, NOAA for weather satellites and a variety of domestic and international communications activities.

SUMMARY

We are planning a very ambitious program for FY 1983 with the initiation of operational Space Shuttle missions, the first flight of the Spacelab and the continuation of ELV operations. Although there is risk, I firmly believe we can achieve our goals with the requested level of funding.

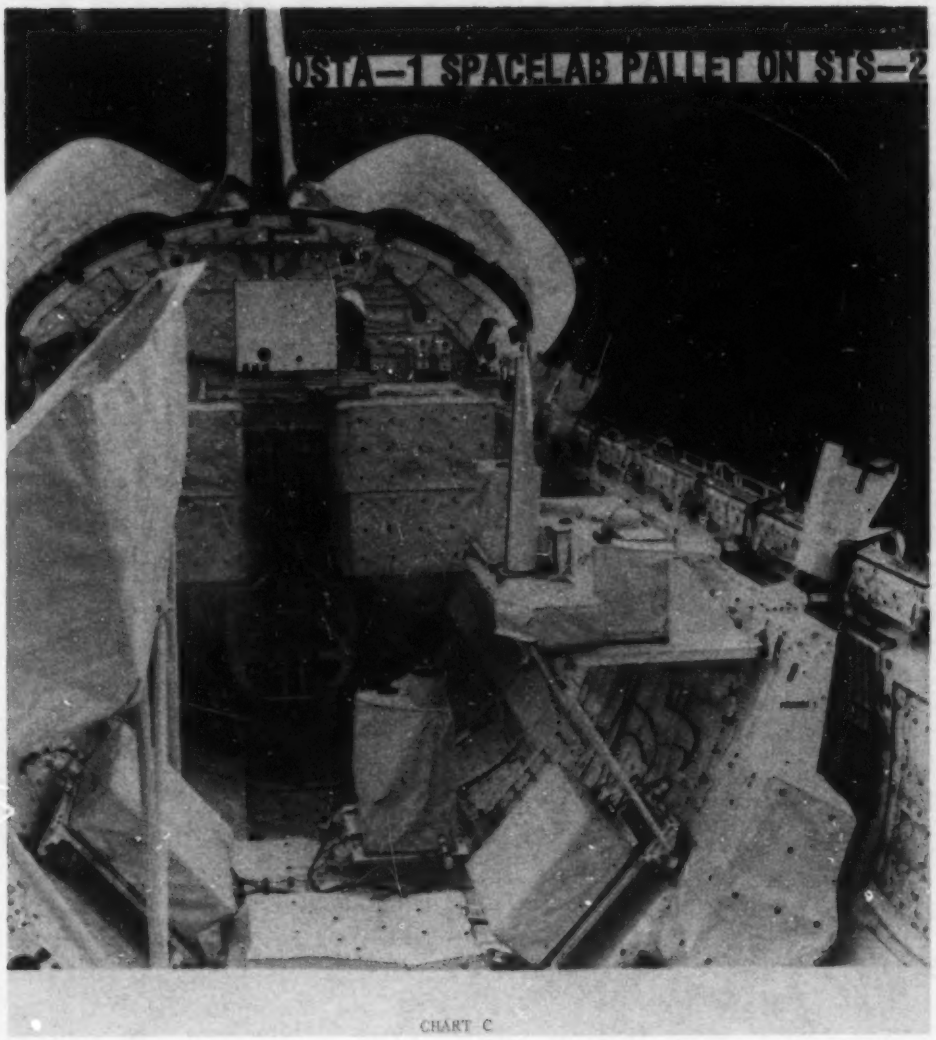


CHART C

SPACE TRANSPORTATION OPERATIONS

SUMMARY

FY 1983 BUDGET ESTIMATE

(MILLIONS OF DOLLARS)

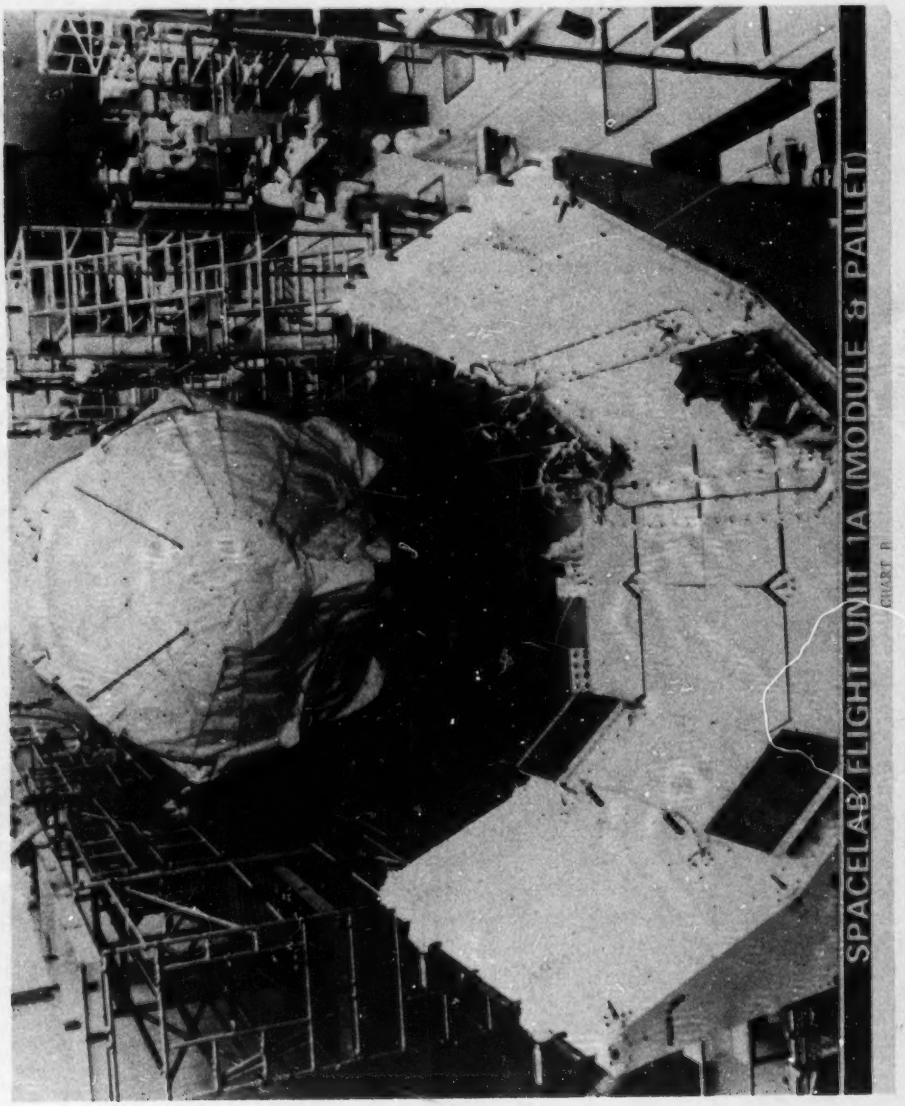
PROJECT	FY 1982	FY 1983
SPACE FLIGHT OPERATIONS	679.9	1580.7
STS OPERATIONS	523.0	1414.1
STS OPS CAP DEV	56.1	53.4
SPACELAB	100.8	113.2
EXPENDABLE LAUNCH VEHICLES	31.2	42.8
TOTAL OSTO	**711.1**	**1623.5**

OFFICE OF SPACE TRANSPORTATION OPERATIONS

1981 ACCOMPLISHMENTS

- **ELEVEN SUCCESSFUL ELV LAUNCHES**
  - 2 NASA AND 9 REIMBURSABLE MISSIONS
  - FIRST 3 FLIGHTS OF PAYLOAD ASSIST MODULE (PAM—D) SUCCESSFUL
- **ACCEPTED DELIVERY OF FIRST SPACELAB FLIGHT UNIT (DEC 1981)**
- **FIRST OPERATION MISSION OF A SPACELAB INSTRUMENT PALLET ON THE SHUTTLE (OSTA—1 ON STS-2)**
  - DEMONSTRATED SHUTTLE CAPABILITY FOR SUPPORT OF ON-ORBIT SCIENTIFIC EXPERIMENTATION
- **FORTYONE ADDITIONAL REIMBURSABLE PAYLOADS SCHEDULED ON SHUTTLE AND ELV'S**
- **SIGNED ONE SHUTTLE LAUNCH SERVICE AGREEMENT (LSA's) AND THREE ELV LAUNCH SERVICE AGREEMENTS. SEVERAL OTHER SHUTTLE AND ELV LSA'S READY FOR SIGNATURE**
- **TWENTY- EIGHT NEW SMALL SELF-CONTAINED PAYLOADS (GETAWAY SPECIALS) BOOKED AND 30 LSA'S SIGNED**
- **10 EXTERNAL TANKS AND 4 SETS OF SOLID ROCKET BOOSTERS IN PROCESS**

CHART A


SPACELAB FLIGHT UNIT 1A (MODULE & PALLET)

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY CONGRESSMAN FLIPPO DURING THE HEARING BEFORE THE HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS ON FEBRUARY 10, 1982, TO DR. WEISS.

QUESTION O-1

Since Mr. Beggs observed yesterday that the first step to move into an operational Shuttle is to reduce or streamline NASA and contractor personnel, the planning effort must be moving along.

(a) What decisions have been made on Headquarters and field center roles and the order of magnitude of the personnel to operate the Shuttle?

(b) What will the centers and people who won't be carried into the operational system be doing?

ANSWER O-1

(a) At this point in time no additional decisions are required concerning Headquarters and field center roles or the order of magnitude of the personnel needed to operate the Shuttle. The decisions that have been made concerning the roles and work force will permit us to achieve the transition to the operational Shuttle era. As we implement the transition and learn, we will make additional adjustments to the work force, with a goal of reducing to lower levels than are currently planned. For example, as part of the FY 1982 and FY 1983 budgets we are challenging the centers to reduce the work force to achieve operating efficiency.

(b) Our transition planning retains an operational role for all of the centers that are currently responsible for Shuttle DDT&E. The portions of the work force that are not needed for STS operations will be utilized for new programs or released.

QUESTION O-2

In the move to an operational STS, is NASA considering including other related functions, such as, tracking and data into the STS operational organization?

ANSWER O-2

While there is a continuing assessment of functional and organizational arrangements to best serve the operational space transportation system, there is no current planning to include tracking and data in the Space Transportation Operations organization.

QUESTION O-3

We understand the Office of Space Science and Technology Policy is looking at institutional arrangements for the Shuttle. What is the timeframe for their study? Is NASA participating? When, if possible, will the recommendations be available to the Congress?

ANSWER O-3

The Office of Space Science and Technology Policy (OSTP) is including arrangements for the Shuttle in its study of institutional arrangements. This study is planned for completion this summer. The OSTP Space Policy Study schedule includes completion of Space Policy Directives and legislative initiatives, if any, by August 1982. NASA is directly involved in supplying inputs to the study and, in fact, has two senior individuals directly assigned to the study group with further support on the institutional questions. It is presumed that study outputs, which might involve changes to current arrangements, would be provided to the Congress.

QUESTION O-4

Dr. Weiss, last year you reported that staffing was underway for the STS Operations Effectiveness and Planning Office.

(a) What is the status of this office.

(b) What planning efforts are underway and when will they be completed?

ANSWER O-4

(a) The office is not yet completely staffed; however, five positions are currently filled versus a projected seven.

(b) Planning efforts are now underway in the areas of future institutional options for STS operations and marketing of the STS. Both efforts are directed at supporting the development of basic NASA policy, evaluating and recommending functional relationships among NASA, other Federal agencies, and the private sector.

As explained in the previous questions, we are currently supporting an OSTP study on institutional options both through direct participation and supporting in-house studies. Those studies are expected to result in space policy recommendations this summer. More detailed internal NASA studies will continue beyond that point, but the direction and timetable for them must be determined after the OSTP study is complete.

Planning for the STS marketing program is underway. Currently, emphasis is on developing policies including pricing and establishing overall marketing plans with specific objectives. This should also be completed by this summer.

Development of an overall strategic plan, of which institutional options and marketing studies are the most critical elements, is targeted for internal review this summer. Continued activity beyond that point would depend on the results of the review.

QUESTION O-5

We also understand that STS pricing policy is under review. The Washington Post reported on Sunday that large price increases for flying on the Shuttle will be instituted in 1985 and after.

(a) What is the status of the pricing policy review and, if you can, tell us where significant changes are being considered?

(b) Has there been any reaction to the pending large price increases recently published?

(c) Can you explain for us why the large price increase? Is it just rising costs? Is it an effect of the decreasing flight rate?

(d) With the pricing increases, how will we stack-up versus Ariane?

ANSWER O-5

(a) In accordance with NASA's published Shuttle Reimbursement Policy, NASA will establish a new price for a standard Shuttle mission flown in 1986. The price of Shuttle flights is fixed for the first three full fiscal years of operations; i.e., commencing with STS-5 (November 11, 1982) and ending September 30, 1985. The basis for the new price is currently in preparation for final review and approval by the Administrator.

(b) Our preliminary assessment is that the new price will be on the order of 75% to 100% higher than the fixed price to users for the first three years of Shuttle operations. User reaction to the Washington Post has been minimal. We believe users are waiting for official release of the new Shuttle price.

(c) The price increase, in part, is due to rising costs. In addition, price will be impacted by an eventual flight rate determination.

(d) Although the anticipated price increase is significant, the shared price charged users for a Delta

class or Atlas-Centaur class communications satellite will remain competitive with Ariane.

QUESTION O-6

We noticed in the NASA reorganization that KSC, JSC and MSFC "report" to the Office of Space Transportation Systems. Will this limit the ability of the Office of Space Transportation Operations to move to a Shuttle operations phase or is appropriate coordination taking place?

ANSWER O-6

The recent NASA reorganization will in no way limit the ability of the Office of Space Transportation Operations to move to a Shuttle operations phase. The NASA reorganization did not alter the programmatic responsibility of the Associate Administrator for Space Transportation Operations nor the manner in which the centers report to him concerning program matters. In addition, there continues to be very close and formal coordination, as well as joint program planning, budgeting, and management between both offices as we evolve to a Shuttle operations phase.

QUESTION O-7

What is the status of the Space Transportation Company's proposal to the Government regarding STC's offer to provide funds to purchase a fifth orbiter?

(a) In your view, is the proposal complete or does it lack critical components?

(b) What are your views on the proposal?

(c) Are there other similar industry proposals which the Government is considering?

ANSWER O-7

NASA has received a proposal from the Space Transportation Company regarding their procurement of the fifth orbiter in return for certain commitments by NASA to provide a return on their investment. The proposal is proprietary and is being treated as such during NASA's evaluation. Since there are many aspects of such a venture which must be considered by NASA for evaluation purposes as well as those which may potentially be considered competitively important, it is not possible at this time to release information regarding the STS proposal. After a careful evaluation which NASA intends to provide as rapidly as possible, we will make available our evaluation to the Congress and will include observations on the potential for legislation which might be necessary for this or similar propositions if they are to prove feasible.

QUESTION O-8

What is the status of the Delta and Atlas-Centaur production lines? What is NASA planning on doing beyond 1986-1987 with the demand for launches apparently growing?

ANSWER O-8

The Delta and Atlas-Centaur production lines are being maintained primarily with reimbursable user funds and will continue this way as long as users require the use of a Delta or an Atlas-Centaur vehicle. Specifically, the Atlas-Centaur production line is totally maintained by reimbursable customer funds since NASA has no current planned use for this vehicle. The Delta, however, is still being used for NASA missions (Landsat-D, D', and AMPTE) and will require appropriated funds in FY 1983 and subsequent years. However, the NASA mission funding represents a small piece of the Delta production and launch requirement.

NASA Delta and Atlas-Centaur launch vehicle planning is concentrated on the use of Delta and Atlas-Centaur with communication satellites through the 1985-1986 period. Because a 3 year procurement cycle is required for hardware and support for these vehicles, we have been approaching their continuation on a year-to-year basis. Currently, known requirements will be satisfied through the end of 1986.

QUESTION O-9

(a) What amount of FY 1983 funds is planned for the follow-on Spacelab procurement?

(b) What would be the impact of a decrease in this funding request?

ANSWER O-9

(a) We have planned $49.3 million for the Spacelab FY 1983 budget request for follow-on Spacelab procurement.

(b) We have already reduced the FY 1982 level for Spacelab follow-on procurement by $40 million. Any further cuts may necessitate a renegotiation of the fixed price contract with Europe where hardware is already being delivered. Such renegotiation of this contract could result in increased costs to the U.S. A reduction could also cause a delay in some of the Spacelab hardware from the follow-on procurement which is required to support the Spacelab missions listed in the current flight manifest.

OFFICE OF SPACE TRANSPORTATION OPERATIONS

SPACE TRANSPORTATION SYSTEM MANIFEST SUMMARY

	NUMBER OF LAUNCHES				
	82	83	84	85	86
SPACE SHUTTLE					
COMMERCIAL/FOREIGN	0	2	3	4	5
DOD	1	0	2	4*	6
NASA	2	3	5	5	6
SUBTOTAL	3	5	10	13	17
EXPENDABLE LAUNCH VEHICLES					
COMMERCIAL/FOREIGN	9	6	8	5	5
DOD	1	5	5	7	1
NASA (INCLUDE NOAA)	3	6	1	4	—
SUBTOTAL	13	17	14	16	6
TOTAL	**16**	**22**	**24**	**29**	**23**

* PLUS POSSIBLE BACKUP MISSION

CHART D

OFFICE OF SPACE TRANSPORTATION OPERATIONS

SHUTTLE/ELV REIMBURSABLE USERS
(EXCEPT OTHER U.S. GOVERNMENT AND DOD)

DOMESTIC PAYLOADS BOOKED					FOREIGN PAYLOADS BOOKED				
USER	TOTAL	ELV ONLY	SHUTTLE ONLY	DOUBLE BOOKED	USER	TOTAL	ELV ONLY	SHUTTLE ONLY	DOUBLE BOOKED
AT&T LONG LINES	4	2	2	–	WEST GERMANY (BMFT)	2	–	2	–
GTE SATELLITE CORP	4	2	2	–	MBB (WG)	1	–	1	–
HUGHES COMM, INC	6	6	–	–	TELESAT CANADA	10	1	9	–
HUGHES COMM SERVICES, INC	5	–	5	–	INDIA	2	1	1	–
SOUTHERN PACIFIC COMM	3	–	–	3	INDONESIA	2	–	2	–
SATELLITE BUSINESS SYSTEMS	2	–	2	–	ARAB SATELLITE COMM ORG	2	–	2	–
SPACECOM	4	–	4	–	AUSTRALIA	4	–	–	4
SATELLITE TELEVISION CORP	6	–	6	–	COLOMBIA	2	–	2	–
COMSAT GENERAL CORP	4	4	–	–	ITALY	1	–	1	–
RCA AMERICAN COMM, INC	16	5	10	1	JAPAN (SHARED SPACELAB)	1	–	1	–
WESTERN UNION TELEGRAPH CO,INC	4	2	1	1	UNITED KINGDOM	2	2	–	–
U.S. SATELLITE SYSTEMS	1	1	–	–	NATO	2	–	–	2
AMERICAN SATELLITE CO.	3	–	–	3	RADIO—TELE—LUXEMBOURG	3	–	3	–
					INTELSAT	20	5	14	1
					CNES (SHARED SPACELAB)	1	–	1	–
TOTALS	62	22	32	8	TOTALS	55	9	39	7

CHART E

OFFICE OF SPACE TRANSPORTATION OPERATIONS

SMALL SELF-CONTAINED PAYLOADS

RESERVATIONS	TOTAL = 322
INDUSTRIAL	158
EDUCATIONAL	85
INDIVIDUAL	51
U.S. GOVERNMENT	28

MILESTONES

• FIRST LSA SIGNING		6/81
• PROOF FLIGHT CANNISTERS	STS—3	3/82
• FIRST GAS PAYLOAD	STS—4	7/82
• UP TO 5 GAS PAYLOADS	STS—5	11/82

CHART F

OFFICE OF SPACE TRANSPORTATION OPERATIONS

FY 1983 BUDGET
SUMMARY OF REQUIREMENTS

(DOLLARS IN MILLIONS)

	FY 1982	FY 1983
• SPACE SHUTTLE	2163.0	1718.0
DDT & E	898.0	–
PRODUCTION	1260.0	1585.5
CHANGE & SYSTEMS UPGRADING	–	72.5
PERFORMANCE AUGMENTATION	5.0	60.0
• SPACE FLIGHT OPERATIONS	895.9	1707.0
DTMS/ENGINEERING & TECHNICAL BASE	184.0	82.4
ADVANCED PROGRAMS	8.8	11.9
STS OPERATIONS CAPABILITY DEVELOPMENT	79.3	85.4
(UPPER STAGES DEVELOPMENT)	(23.2)	(32.0)
SPACELAB	100.8	113.2
STS OPERATIONS	523.0	1414.1
• EXPENDABLE LAUNCH VEHICLES	31.2	42.8
TOTAL	3090.1	3467.8

CHART G

Specifically, the follow-on production hardware is required in early 1983 in order to support the SL-3 and the German D1 missions.

QUESTION O-10

(a) What effect has Ariane had on potential international Shuttle users?

(b) How many prospective Shuttle users have indicated they may pursue an Ariane launch instead?

ANSWER O-10

(a) The Ariane system, which has just been declared formally operational after four flights (one failed), is capable of launching two Delta-class payloads or one Atlas-Centaur class payload into geostationary transfer orbit. Virtually all of the communications satellites currently planned or under construction around the world are within the weight limits of Ariane 4 (currently estimated at 4400-5200 lbs.), the largest Ariane variant that has been approved for development. For this reason, and because of attractive price and financing, Ariane launch services are competitive with NASA launch services, particularly those provided by expendable launch vehicles. We believe, however, that cost, reliability and other advantages, such as on-orbit checkout and reflights, offered by the Space Shuttle, make it a formidable competitor with Ariane for this business.

(b) Our information indicates that 9 users have paid earnest money and currently have double-booked 11 satellites on both STS and Ariane. These users are Luxembourg, Intelsat, Colombia, Satellite Television Corp., Canada, Western Union, Arabsat, Brazil and RCA. In addition, one user, General Telephone, with 2 satellites is double-booked on Ariane and U.S. expendable launch vehicles, and two users, Southern Pacific and Australia, have triple-booked three satellites on Ariane, STS, and U. S. expendables. Double and triple-booking makes it difficult to assess the final outcomes, and this uncertainty will continue until the required initiation of large progress payments 30-36 months before launch, when it becomes very expensive to maintain multiple launch commitments.

QUESTION O-11

How many U. S. commercial users have deposited earnest money for use of the Ariane launch vehicle?

ANSWER O-11

We understand that five U.S. commercial users have deposited earnest money with Arianespace to schedule Ariane launches. These users are Western Union, General Telephone, Southern Pacific, Satellite Television Corp., and RCA. Three of these users have already signed contracts with Arianespace. These users, with a total of five payloads, are Western Union (one), General Telephone (two), and Southern Pacific (two). Only one user has dropped his U.S. launch reservation which was for a Delta ELV. The final outcomes remain uncertain as long as users continue to book multiple launch commitments.

QUESTION O-12

Do the available power resources provided by the Shuttle/Spacelab satisfy user requirements?

ANSWER O-12

The current power resources provided by the Shuttle to Spacelab can provide up to 7 days of service for the average Spacelab mission. Several of the currently manifested missions originally requested more than 7 days. These included the NASA missions Spacelabs 2, 3, and 4 and the West German missions D1 and D4 which originally requested 10-day missions. However, all Spacelab flights have now been reconfigured for no more than 7 day missions.

QUESTION O-13

From a user standpoint, when is the Power Extension Package and 25 kw Power Module required?

ANSWER O-13

There is an awareness in NASA that some Spacelab users prefer mission durations and energy power levels that exceed the present capability of the Space Shuttle system. As a result, NASA has examined methods to achieve both objectives and concluded that a space platform based on the 25 kw Power Module studies provides the most optimum solution. The Power Extension Package (PEP), using much of the technology of the Power Module development, is considered a subsystem of the Power Module but is of lower priority because of its impact on the normal Shuttle operations planning - longer duration Shuttle missions means fewer flights per year.

The 25 kw Power Module design, which is the basic element in both the PEP and Space Platform, has been rescoped as part of NASA's continuing Phase B effort to make it more responsive to user requirements. The rescoping temporarily defers the sortie mode or PEP concept and

concentrates on a capacity of 12.5 kw of electrical energy with heat rejection capability to be used in a freeflying mode or as a "Space Platform."

The Space Platform would be a new element in NASA's space operations capability development and, consequently, requires New Start approval before implementation. The need date will be dictated by the rate of growth of several areas of space applications: remote sensing of earth resources, materials processing, and space technology. The unqualified success of STS-2 experiment operations has resulted in requests for a reflight of the same equipment as soon as possible and for longer durations. The materials processing experiments to be conducted in the next 2 or 3 years and the Spacelab technology experiments to be flown in 1984 will undoubtedly result in similar requests.

QUESTION O-14

Dr. Weiss, are you satisfied with the division of responsibility between Space Transportation Operations and Space Transportation Systems program offices?

ANSWER O-14

Divisions of responsibilities between Space Transportation Operations and Space Transportation Systems are characterized by the hardware and launch preparation activities under the cognizance of the Space Transportation Systems office and the customer related aspects of the space transportation business under the Operations organization. Thus the focus of the Systems office is putting into place a Shuttle system and assuring its performance, progressive emphasis on cost effectiveness and turnaround time improvement to meet requirements established by the Operations office. This is, in fact, complementary to the customer service and support efforts of the Operations program office during a period of considerable mix of DDT&E and Operations activities. The emphasis of the latter at this time is in development of customer and, therefore, cargo related aspects for Shuttle, providing launch services with the well established Expendable Launch Vehicles and assuring availability, usage and success of the Spacelab.

QUESTION O-15

In the budget the DTMS function has been renamed Engineering and Technical Base and the funding has been significantly decreased.

(a) Have the functions and/or funds been transferred to other programs or have they been terminated?

(b) If they have been terminated, what of the people and/or contractors who were performing this function?

ANSWER O-15

(a) In the Committee on Science and Technology report on the NASA FY 1980 Authorization Bill, it was requested that the Agency submit a method which would address future assurances for the Shuttle operational period that: "(1) assure adequate support of the research and development institutions, (2) provide sufficient visibility of program support costs, and (3) assure that all feasibly identifiable costs are charged to benefiting program." On August 5, 1980, NASA notified the Committee by letter of its plan to start the Engineering and Technical Base in FY 1983 to comply with their request.

Based on this request and starting in FY 1983, the Engineering and Technical Base will fund only the R&D capability that is necessary to continue a basic development base in support of various Space Transportation Systems program elements. This capability will be maintained at the Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, and the National Space Technology Laboratories. Any demands in excess of this R&D core capability will be funded by the benefiting programs, such as Shuttle Production and STS Operations.

Using this approach, Johnson Space Center will support a one-shift operation of its laboratories. The Central Computer Complex will utilize a two-shift operation. The funding for the Center Operations will be shared equally between the Engineering and Technical Base and the benefiting program, STS Operations and Shuttle Production.

Kennedy Space Center will have a minimal manpower level to maintain, develop, and capitalize on the research and development technologies available to enhance space flight hardware, ground processing and support systems.

For the Marshall Space Flight Center and the National Space Technology Laboratory, they will be extending their basic core capability of maintenance and operation of the automatic data processing equipment, various facilities, test stands, and providing laboratory services.

(b) By definition of the Engineering and Technical Base (ETB), all activities over and above this core capability that represent direct program dedicated capability (such as those required for Space Transportation Systems Operations or new development activities conducted at these Centers) will be budgeted by and charged to the benefiting programs. It is a fundamentally different management concept,

which is based on a critical accounting change. It will not produce immediate savings. However, in the future, the elimination of marginal support requests should eventually produce real savings.

QUESTION O-16

The FY 1982 Operating Plan reduced the operations effectiveness line from $10 million to $3 million. The FY 1983 proposal requests $4 million. (Estimates RD 2-13)

(a) What had been planned that has been dropped?

ANSWER O-16

(a) As originally proposed, the Operations Effectiveness program, in addition to undertaking the design and development of a large number of specific hardware improvements, would have also provided for an aggressive strategic planning program, plus analysis support for current operations.

The reduced budget numbers reflect the shifting of the conduct of the following tasks:

(1) Continuing analysis support for current operations under Payload and Operations Support;

(2) Substantially rescaling strategic planning efforts and placing more reliance on analysis by in-house (civil service) personnel.

(3) Shifting responsibility for implementation of improvements with substantial starting costs to the R&D or line operations programs as appropriate.

The current program will allow us to continue independent analyses for the critical planning efforts.

QUESTION O-17

What are the commercial users main concerns about flying on the Shuttle? How is NASA handling them?

ANSWER O-17

The commercial users main concerns about flying on the Shuttle are considered to be assured launch capability, competitive price for launch services, complexity of Shuttle safety requirements, and financing of launch services.

The majority of commercial users are SSUS-D class users. Assured launch capability for these users is approached through a combination of Delta ELV's and the build-up to

a 4 Orbiter fleet (1985). Continuous activities are underway to improve production, processing, and turnaround to enhance STS launch flexibility and margins.

Safety complexity stems from taking a conservative approach based on prior manned space programs and the limited Space Shuttle flight experience to date. As the Shuttle program matures, improvements in the application and effectiveness of safety requirements, reviews and waiver processing will evolve.

The subsidized financing arrangements offered to users by Ariane are very attractive. NASA has been discussing financing arrangements with the EXIM bank and U.S. banks to promote development of competitive financing arrangements for Space Shuttle users.

QUESTION O-18:

Now that the push for STS-1 is past, is cargo processing receiving the attention it needs?

(a) What is the status of Launch Service Agreements with the commercial users?

(b) What is the status of cargo processing facilities and hardware, primarily at KSC?

ANSWER O-18:

(a) The status of our Launch Services Agreements are noted below:

	LSA STATUS	
COMMERCIAL USERS	NEGOTIATIONS	LSA TARGET SIGNING
INTELSAT-1, 2 & 3	--	Signed 5/80
SBS-C & D	--	Signed 7/80
INDIA/INSAT-1B	--	Signed 11/80

INDONESIA/PALAPA-B1&B2	--	Signed 12/80
W. GERMAN/SPAS-01	--	Signed 6/81
TELESAT/CANADA-E, F, I and H	Complete	3/82
W. GERMAN/BMFT-D1, D4	Final Stages	3/82
ARABSAT A & B	Complete	3/82
TDRSS-A, B, C, D	5/82	
RCA H, I, J, K, L, M	Preliminary Meeting	9/82
HUGHES/SYNCOM IV 1 thru 5	Draft LSA Sent	7/82
AT & T (TELESTAR 3 C & D)	Preliminary Meeting	9/82
GTE/GSTAR C, D	Draft LSA	10/82
AUSTRALIAN/DOMSAT		11/82
LUXEMBOURG/DBS-LUX 1, 2, & 3		FY 83
ITALIAN/CNR-IRIS		FY 93
COLUMBIA A, B	Preliminary Meeting	7/82
RCA, DBS 1, 2, 3		FY 83
INTELSAT VI-1-12		FY 83
WESTAR-VI, VII	Draft LSA	10/82
SPC-B, C, D		11/82
STC 1,2		FY 83
TELESAT J, K, L, M, N		FY 83
MDAC EOS		FY 83
SPACELAB J (JAPAN)		FY 84

(b) The cargo processing facilities have been concentrated on OFT payloads to date, for receiving and testing of Spacelab, and for developing capabilities for payloads. Specific facility status is shown below:

Horizontal CITE (Cargo Integration Test Equipment): Already completed processing OSTA-1 for STS-2 and OSS-1 for STS-3. Everything is working well. Next use is Spacelab processing.

Vertical Processing Facility (VPF): The facility is ready for the IUS Pathfinder vehicle tests in March 1982. The Orbiter General Purpose Computers are being installed and will be checked out and ready for service on-schedule (8/15/82).

Spacecraft Assembly and Encapsulation Facility is on schedule to support fueling for the first two vehicles.

Solid Motor Assembly Building (SMAB) is on schedule. The IUS Pathfinder is in this facility now for checkout.

Delta Spin Test Facility (DSTF) and Explosive Safe Area (ESA): These two facilities are presently supporting;

however, there are still some options on ways of processing back-to-back Payload Assist Modules (PAM) check-outs in future years.

PETS (Payload Environmental Transport System) and MMSE Transporter/Canister/Strongback): Both have minor mods that are planned for completion by March 1982.

O&C Cargo Capability continues on the schedule build up of capability for Spacelab Level IV and Life Sciences.

Shuttle Facilities (OPF, VAB, PAD) that have Payload interfaces: These have all been validated by the first two flights. No problems are anticipated.

QUESTION O-19

What does NASA expect to accomplish with the cargo processing contract? What will be the impact on civil service personnel?

ANSWER O-19

With the cargo processing contract NASA will accomplish the following:

- Simplifying users entry into, interface with, and utilization of STS.

This will be done by the consolidation of organizations, contractors and lines of authority, responsibility, and accountability and by establishing new contracts with scope and structure conducive to self-sufficiency and cost/performance incentive awards.

Examples of this consolidation under one contractor for hands-on work are:

(1) Host various users in the facilities where payloads are built up and checked out preparatory to aggregation into a Shuttle cargo;

(2) Perform the Spacelab hands-on experiments and payload integration (Level IV, III) into the Spacelab modules and pallets;

(3) Perform hands-on aggregation of payloads in the Horizontal and Vertical CITE (Cargo Integration Test Equipment) in preparation for placement in the Shuttle Orbiter;

(4) Perform the maintenance and operations on all of the cargo-related ground support equipment and facilities.

The impact on civil service will be an increased efficiency by diminishing the level of day-to-day management necessary to plan, schedule and control cargo operations. This will permit accommodating a continuing escalation in launch rate without additions to civil service manpower.

Mr. FLIPPO. Thank you very much for your testimony.

Gentlemen, could you join us again, please.

Dr. Weiss, we understand that the Office of Science and Technology Policy is looking at institutional arrangements for the Shuttle. Could you tell us anything about the time frame for their study, and whether or not NASA is participating in that study, and when, and if possible, will those recommendations be available to the Congress?

Dr. WEISS. I can't give you a complete answer. To the best of my understanding, the target for the establishment of the space policy which will include considerations of institutional location of the space transportation system will be available late spring or summer. We are contributing as is the Department of Defense and other people who have been called in. In fact, NASA has two representatives who are supporting on a permanent basis the activities of Dr. Keyworth's committee. In addition, we are proceeding internally with the institutional option studies that feed in through Phil Culbertson to the Keyworth committee.

Mr. FLIPPO. We understand the STS pricing policy is currently under review. The Washington Post reported some large increases. I wonder if you would care to comment on the reaction to that statement, and what are the factors driving the increase. Is it a factor of reduced flight rates? What is really driving those cost increases?

Dr. WEISS. We have recognized over the past several years that the cost relationship to the price, which we established in 1977 for the period 1982 through 1985, was divergenting. Cost considerations are important because we are looking for operations cost recovery—in other words, an ability to cover our cost of operations in the price or fees we charge. They have grown not quite the same way as Mr. O'Toole reported, however. First, his indication that there would be a price change in 1985 is incorrect. Our level pricing is established through fiscal year 1985; and the price change we anticipate will be initiated in fiscal year 1986. It will be significant, simply because of the increase in the cost of the expendable hardware, the consumables we use in flight, and our learning process which has defined how much manpower it takes to process a vehicle at the KSC and to support the missions at JSC. The accuracy of Mr. O'Toole's numbers is difficult for me to assess, because we don't have an established price at this time. We are providing to the Administrator, Mr. Beggs, a variety of options which must be addressed in terms of pricing policy before we establish a price, and we will perhaps again choose a limited period.

As far as the reaction to the O'Toole article, it has been much less than I had anticipated, partly because in our periodic user meetings, we have indicated that there will be an increase in price. Our statements have generally dealt with a figure on the order of a 60 to 75 percent increase for communications satellites over the current level. Now, it has to be recognized that when we talk about full Shuttle usage, our pricing factor against a full Shuttle flight cost, for, let's say, a Delta class payload, the standard modest-sized communications satellite, is a little over 20 percent. So, that as Mr. Beggs commented on his $70 odd million cost for a Shuttle in

today's dollars, that would mean that a communications satellite could fly for approximately $14 million.

One minor comment, because of the cost relationship to price is obviously a very strong area of concern within the Agency, some of the comments General Abrahamson made earlier and those of Mr. Beggs yesterday reflect the need to get our costs and our related turnaround times down to the minimum possible in order to retain a competitive price.

Mr. FLIPPO. The Delta and Atlas Centaur you are packaging and offering to users. Are you engaged in any discussions? Do you anticipate having any discussions toward the commercialization of the Atlas Centaur or the Delta. Do you see any interest in that?

Dr. WEISS. We see periodic interest and we have talked from time to time; though not with people outside the community that are actually involved in those systems. We have discussed, for instance, the potential of private operation of the Delta vehicles with the McDonnell-Douglas people. The closest we have been able to come has been a willingness to sell the vehicles privately, but to use NASA capability in conjunction with the contractor to provide the services, and thereby build a composite price that might have some benefits because of the relief from NASA procurement overhead to the total pricing.

I recently discussed the possibility of a pilot approach to private operation of the space transportation system through the expendable launch vehicles with the McDonnell-Douglas people. Their reaction was rather negative; and they have made some assessment of it since John Yardley's return there.

Their comments were that they couldn't see doing it without violating antitrust regulations, by joining in price fixing with NASA, who would be their chief competitor, and that we might have to manage their scheduling as well. If we were to go ahead with some of the package deals that we talked about earlier with the competition, it would involve some questionable practices that just don't fit into today's way of doing business.

Mr. FLIPPO. General Abrahamson, you had made the comment, I believe, that you feel that the budget, planned budget for the year will permit the orbiter vehicles to be delivered on schedule. Let me ask you, if the contractor agrees that the budget will support the delivery schedule, and do you believe that the delivery schedule for the Shuttle main engines funds are adequate for that?

General ABRAHAMSON. Mr. Chairman, I think there is general agreement in several of our cost projections. However, I would be wrong to indicate to you that there is ever perfect agreement between the contractor and the Government on price. I guess I would be concerned if there were.

I think that the contractor in general agrees with the Government's overall price projection within a small variance. However, usually he says in the near term that there are some added expenditures that he needs to have in the budget to do the work. Of course we are working those, and working those very diligently with the contractor.

But in general there is at least agreement in terms of understanding the elements of cost, and some agreement on the cost methodology, so that we come quite close in terms of totals.

Mr. FLIPPO. I appreciate your response. Let me approach it a little differently. Could you tell us something about the rate of change orders? Are there many change orders on the downstream orbiter vehicles? Is that increasing, decreasing?

General ABRAHAMSON. I would like to get you some very specific information for the record because this is the kind of a question that I think needs to be answered more specifically than I am prepared to do this morning.

[The information follows:]

SPACE SHUTTLE CHANGE TRAFFIC TREND

As the program has progressed from initial component testing to flight demonstration, the NASA directed technical changes have been decreasing. In fiscal year 1979, over $100 million in changes were authorized. By fiscal year 1981, this had decreased to approximately $70 million. Through January 1982, the fiscal year 1982 changes have been running at a rate which annualized, will be approximately $60 to $65 million. The table below indicates the value of approved technical changes over the past few years.

Estimated value of approved technical changes

Fiscal year:	*Millions*
1978	$110
1979	105
1980	95
1981	70
1982 October to January	21

The fiscal year 1982 changes reflect identified fixes for problems encountered during STS–1 and STS–2 such as the Solid Rocket Booster (SRB) overpressure on the launch pad, and the required fixes to SRB hardware damaged during re-entry.

With additional flight experience and system maturity, we expect that this "make work" change rate will continue to decrease. Major area of future changes will be identification or redesigns to increase system performance and reliability, to reduce turnaround times between missions, and modifications of hardware to achieve improved operating efficiencies.

General ABRAHAMSON. The rate of major changes, is, indeed, going down. In all cases in a program at about this point in time, there are a very large number of change orders which are essentially cleaning up the paper. You are catching up with changes that have been made, therefore, many are only paper or drawing changes and those numbers still remain high. Of most significance, and I think the key to your question is will we continue to have significant changes for OV–103 and OV–104 vehicles, or will we be able to stabilize and bring the cost down, by minimizing further development. It's a mixed answer, sir.

I believe that we will have very few changes except important ones to increase performance or some changes such as those recommended by the Safety Advisory Panel that we must evaluate and follow up on.

Let me give you one example of the kind of change we will incorporate on OV–103. We have now nearly completed development of a tile which is about half the weight of the present tiles, where the weight is approximately 22 pounds per cubic foot. We have nearly completed the qualification of a 12-pound per cubic foot tile. We will replace about 3,000 of those tiles on OV–103 which should yield about 3,500 pounds of additional payload capacity.

That change is an important one that we all agree should be made.

Mr. FLIPPO. The gentleman with good experience in this program, Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

General Abrahamson, could you visit with us a little bit about what successes you are having in improving or reducing the turnaround time?

General ABRAHAMSON. Our projections at this time, I think, are conservative projections [figure 19]. In the terms of two vehicles, STS-2, 125 days, and to STS-3, just breaking about 100, then looking forward to STS-4 and STS-5 to even shorter turnaround times. We are clearly marching down a learning curve. We are very, very pleased with that. The difficulty, and the one we really have to deal with, however, is much further out in time. The projection for STS-8 is 53 days and that is certainly not good enough.

Yesterday, Mr. Beggs mentioned that we need to get substantially below 6 weeks, and he thinks that we can do that on an average basis. I agree that we can. The clear importance is the interactive aspect, and I am sure that that may be at the heart of your question. If we can reduce turnaround time, that interacts back into costs in several ways: One, we can reduce the numbers of people involved; second, we can reduce the number of the solid rocket boosters that are required to be in the inventory. Each of those boosters is expensive. So, if we can turn them around faster, we can have a smaller inventory and less investment.

We do have a management activity to look into all aspects of this turnaround, I am looking forward to the success in that effort. But, it will take time. We have to just carve it out a little bit at a time.

Mr. WINN. Based on your conservative estimates, how much money can you save? Have you run that down that far?

General ABRAHAMSON. Sir, I haven't made that estimate at this point in time.

Mr. WINN. Are there any additional facilities that are not currently in the budget that are required to meet the 24 flights per year?

General ABRAHAMSON. There are none.

Mr. WINN. Any we haven't heard about, or you haven't given us in your full testimony?

General ABRAHAMSON. There were some that are proposed by the centers. There always are, of course, because each center looks at these as priority elements. While I wasn't at NASA in the early part of the budget process, a judgment was made that we don't need certain of the items at this time.

One example of a fairly expensive one is the external tank storage facility at Michoud. The centers felt that that would be a useful thing to have. We clearly don't need it at this time with our present planning.

Mr. WINN. Where do you see it, in what budget, 1983, 1984? We are discussing 1983.

General ABRAHAMSON. I think the first time we would look at it again would be the fiscal year 1984 timeframe, sir.

Mr. WINN. 1984?

General ABRAHAMSON. The key point is, that decision is driven by just how many extra tanks we can afford to keep on hand, which will be a measure of our flexibility in being able to insure

that we can meet some of the missions that Dr. Weiss projects. The need for the facilities will really be determined by whether or not we can afford to purchase some extra tanks and have them ready.

Mr. WINN. That is the storage facility.

General ABRAHAMSON. Yes, sir.

Mr. WINN. Any other facilities that we are looking at?

General ABRAHAMSON. Yes, there are some other kinds of facilities.

Mr. WINN. Are there any other facilities that you think might come into the 1983, that would be a problem in the 1983 budget, or that for some reason or another, God forbid, would make us go to the floor for a supplemental?

General ABRAHAMSON. At this point in time; no, sir.

Mr. WINN. So you don't see any new facilities of any type, or additional facilities?

General ABRAHAMSON. As I mentioned, the one area of concern to me is that we move on the mobile launch platform as quickly as possible.

Mr. WINN. Yes.

General ABRAHAMSON. I have made extra room in the budget for the long lead kind of planning and to purchase some of those parts. But, I still expect that that will be a fiscal year 1984 item.

Mr. WINN. General, I wonder if you would care to comment about the Shuttle student involvement program for secondary schools. That kind of intrigues a lot of us.

I understand that this program has recently been moved to your division.

General ABRAHAMSON. We are in the process of doing that, sir.

Mr. WINN. In the process of it now?

General ABRAHAMSON. Yes, sir.

Mr. WINN. What is the program? I think we would like to have that on the record. How committed is NASA to the SSIP? Is the program compatible with the other student educational space payload program, the getaway special? When do you plan to fly the first SSIP-S experiment?

General ABRAHAMSON. Sir, I am just delighted that you asked that question.

Mr. WINN. I am going to do a radio show on it in a couple of college towns.

General ABRAHAMSON. Good. We would like to provide any information that you feel you might need.

Mr. WINN. You can write the show, if you want to. [Laughter.]

General ABRAHAMSON. No, but——

Mr. WINN. That is the best offer I have had since 10:25.

General ABRAHAMSON. I am delighted because I personally feel, and I am sure the fact that you are bringing it up and plan to comment on it, means that you agree that it is an important area for basic science education and the motivation of young people. Of course, that is why it was conceived. It is to stimulate the study of science and engineering. In the initial competition, proposing student experiments to fly on the Shuttle, there were some 86,000 requests, figure 20.

General ABRAHAMSON. It is limited at this point for the secondary school program, grades 9 through 12.

Mr. WINN. I understand.

General ABRAHAMSON. We also have companies who are willing to provide financial and other support for the students. In some cases, it also ends up with scholarships for these students. It provides them a very useful opportunity to see companies in action, science in action, and engineering in action as they build their payload experimental equipment. I was concerned, as I looked into this program, that we need to accelerate the schedule, because we live in a society of instant gratification. These young people need to be able to work on their experiments, and fly them during the period that they are working with a single science teacher, and certainly before they leave school and go on to other endeavors.

So we have tried to accelerate the flight schedule for the students. I now have a promise that the first two of these will be on STS–4 in July. I have a firm commitment that we can place two more on STS–5 and I am trying to accelerate that even more.

My goal is to get a majority of the first 10 winners on those 2 flights. Of course, that depends on the ability of the students to get their experiments ready, as well as the ability of our people to integrate them. Right now the critical path appears to be the students. I am sending out letters to all of the students, asking if there is any way that we can help in that process.

Mr. WINN. I think from your explanation and from what you knew about the program, I think it is very important to encourage these young people. We are well aware and quite concerned about the lack of young people, young graduates, of course, later on, coming into the field. And maybe an early access or affiliation with NASA in some way might want them to see that these young scientists and engineers would like to fill the gaps as they get out of college.

I think it would be a good starting point. Of course, the science fairs that many of the cities hold and school districts hold have been very successful, as you know.

I think this is sort of an additional concept that should be intriguing. I am sure you might have some problems with the students finishing their experiments on time to meet schedules. I don't think that will be too unusual.

Dr. Weiss, whose getaway special will be launched on the STS–4, and what experiment will be flown?

Dr. WEISS. Mr. Winn, I guess I will ask Chester Lee, who is responsible for that manifesting, to explain it.

Mr. LEE. Mr. Winn, Mr. Gil Moore has the first getaway special payload and it will fly on a STS–4. He has donated this space, to five different educational institutes—Utah State University, Weber State College, Weber High School, Ogden, Utah, and Box Elden High School, Brigham, Utah, and the University of California at Davis. There are a total of nine experiments.

Mr. WINN. Do you know what type of experiments they are?

Mr. LEE. They range from algae and duckweed growth and span to fruit fly and brine fish genetic studies.

Dr. WEISS. We can give you a list of those if you would like, Congressman.

Mr. WINN. I am trying to figure out if these types of experiments are—how you would rate the program. Do they tie in with other

typical activities of NASA, industry, academia? These are all college and high schools?

Mr. LEE. These are all college and high schools on the first one. We have several others and the Japanese have one that might fly on STS-5 if we have space available. The Japanese experiment involves a followup on an early scientific endeavor a famous Japanese scientist had conducted on the formulation of snowflakes. We also have others scheduled such as the Goddard Space Center getaway special for STS-5. However, I don't recall the particular experiment that they are processing. The Germans have signed up for 25 of these getaway specials. They have planned a number of material processing techniques that they want to test as soon as possible. Plus, they fly to test some sensors that they would like to have on their spacelab mission scheduled for 1985.

Mr. WINN. When we fly these experiments, we have access to all of the information. Do we work with their scientists, their engineers?

Mr. LEE. Yes, we use the Goddard flight test center as our lead center for the getaway special [GAS]. Goddard personnel have the responsibility to interface with GAS users. Users are required to submit sufficient information to enable Goddard to verify that the payloads meet all safety requirements and NASA does provide advice to the users on their experiments. NASA does not protect the users' proprietary information. The participants exchange information. Another example of cooperation in this program is the case of National Geographic considering making photographic equipment for the educational institutions to use. There is a great deal of cooperation.

Dr. WEISS. As a matter of fact, there are frequent meetings around the country where those involved in the getaway special program congregate, exchange their ideas and in which we have rather strong participation and sponsorship.

Mr. WINN. Would you say that the getaway special program is compatible, or parts of it, with the SSIP program?

Dr. WEISS. Certainly, among other things, the getaway special program is oriented to the canisters that are in the payload bay. You will note that the SSIP is largely using the middeck location.

Mr. WINN. I noticed that on the chart.

Dr. WEISS. The difference lies in the sponsorship. It is an expansion, as it were, of NASA's own sponsorship for growth of science education that leads to the SSIP. The reimbursement aspect of the getaway special makes it, in a sense, a promotional part of our business. As Chet Lee noted, Mr. Gil Moore is responsible for donating some $10,000 to make affordable the use of these university and high school payload developments that we will be flying on getaway special missions.

There are a number of other sponsors providing between $2,000 to $5,000, depending on size of payload. This is encouraging its usage well beyond that of the individuals or the industrial organization that are the fee-paying sponsors.

Mr. LEE. May I add, we hope to fly the New Jersey Camden High School getaway special experiment on STS-5 or STS-6. This high school project has been supported by RCA and deals with an ant colony. The teachers and students are enthusiastic about it. In fact,

although they would like to fly as soon as possible, but they also noted that the time spent in developing the package changed the thinking of the students as to science courses. None of them had previously really been interested in science courses. The school has now seen a great change in the number of students signing up for science courses. The students even worked during the summer vacation on the getaway special experiment.

Mr. WINN. It sounds very good.

Now the typical question we ask every year about this time, though it really hasn't a lot to do with the budget, it has more to do with public relations, I suppose, is what is NASA doing to publicize the getaway special program, the SSIP, these experiments that are going to be aboard the Shuttle and these payloads, how do they benefit the public and how do we tell the public of the advantages that they are receiving for their tax dollar, although a lot of them are paid for by outside firms?

Dr. WEISS. It is a dual-fold answer from my standpoint, and Jim may want to comment from his. I don't think we do as good a job as we should, obviously. But, we are getting more conscious of the necessity of doing a true public affairs job in this area. I have a public affairs officer assigned to my organization who has become very active in generating publicity, largely working with publications and companies who are going to include the activities we are pursuing—getaway special being a very important class because it is a very visible one and reaches a broad audience—their own publications.

Now, this involves the corporate publications where they will have topics on the sponsorship of getaway specials. For instance, RCA is one of the first to include the getaway specials in their annual reports and in messages to their stockholders, which is a relatively new approach.

Mr. WINN. But the public doesn't read RCA's annual report.

Dr. WEISS. No, but I just mention that one.

Mr. WINN. They do read their ads.

Dr. WEISS. They read their ads, and you will see it in their ads, too. In addition, our own NASA publicity for the flights that will cover the PR, as it were, for the upcoming flights will include a good measure of the activity devoted to these new payloads.

I am sure that with respect to the SSIP's, as well as the Getaway Specials, there will be an excellent opportunity with STS–4, and STS–3 will cover the usage of the proving of the cannister. STS–4 will be able to really publicize the experiments being carried, and we would expect to exploit this.

In addition, in meetings, I guess we had a very good one in this building not too long ago in providing recognition to the high school students who had been involved in the program.

So I think we have an increasing consciousness, and we expect to generate this sort of very favorable publicity downstream.

Mr. WINN. I don't think we will ever replace the glamour of the astronaut in the Shuttle. They are international heroes, as they should be.

I would hope we would put more accent on the experiments. There certainly are some of those that could really capture the

public's imagination. There certainly could be good television shows, television specials, radio shows, magazine features.

I hope your public affairs people, as you refer to them, will stay on top of that.

Thank you very much. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Resource requirements for STS in 1983, fiscal year 1983 have increased $440 million when compared to March 1981 projections.

Could you provide for the record the major causes of those increases? And could you tell us what is being done to improve resource requirement projections? And you might reply, if you would like now, about whether you feel that there are adequate program reserves in the fiscal year 1983 budget commensurate with program schedule and risk.

[The information follows:]

The current fiscal year 1983 budget request for the space transportation system programs, which include the Space Shuttle, Space Flight Operations, and Expendable Launch Vehicles, is $445 million higher than the fiscal year 1983 estimate in runout of the fiscal year 1982 Amended Budget. This total of $445 million is comprised of increases of $187 million in the Space Shuttle; $243 million Space Flight Operations activities; and $15 million in Expendable Launch Vehicles.

The Shuttle increase is primarily due to changes in three program areas: the $60 million included in the current fiscal year 1983 budget request for the filament wound case development (there were no funds in the fiscal year 1982 Amended Budget runout) to provide performance augmentation for the Shuttle; and additional $172 million for spares and equipment requirements primarily due to price and quantity increases for orbiter flight and crew equipment spares, External Tank and solid rocket booster rate tooling and External Tank producibility and production readiness efforts; and a $55 million reduction for Shuttle/Centaur modifications related to the decision to discontinue the development of the Centaur upper stage. Other increases totaling approximately $73 million have occurred in a number of Shuttle activities including systems integration efforts, post orbital flight test (OFT) data analysis, modifications to Orbiter 102, spacesuit hardware production, simulator/trainer modifications, and SMM mission unique requirements. These increases have been offset by an allocation of a like amount from the previous fiscal year 1983 estimate for the Changes and Systems Upgrading budget.

In the Space Flight Operations line item, the increase of $243 million is comprised of increases of approximately $280 million for Shuttle Operations manpower and hardware; $17 million for miltimission payload support equipment and manpower increases required for the upgrading of the Mission control Center capability; and $15 million for Spacelab development for systems integration, flight hardware modifications and spares and ground support equipment. These increases have been partially offset by decreases of $60 million in upper stages development and operations related to the discontinuation of the Centaur upper stage development and $8 million in payload support operations requirements.

The Shuttle Operations increase of $280 million includes an additional $135 million for Johnson Space Center activities for mission operations manpower and to procure orbiter vehicle spares and equipment which increased in quantities as well as unit costs, and a $115 million increase for Shuttle processing and launch operations manpower at the Kennedy Space Center. The manpower increase at both centers result from the requirement to maintain the current level of manpower as the STS transitions from development to the operational era. These levels of manpower established by STS-1 and STS-2 experience must be maintained until additional experience in operating the STS is gained and anticipated efficiences are realized which would allow for reduced manpower requirements. Production of solid rocket boosters and External Tanks for operational flights have increased by approximately $30 million due to additional labor and subcontractor costs based on experience during the development phase.

The Expendable Launch Vehicle requirements have increased $14.8 million in fiscal year 1983 for Delta launch vehicles to support NASA missions consisting of IRIS, Landsat-D, Landsat-D' and AMPTE. The increase consists of a combination of schedule delays and decreased hardware production rates.

Because the Shuttle program was a new development effort, early estimates of the necessary resource requirements carried a large range of uncertainty. With the maturing of the development stage and our experience with the first Shuttle flights, future resource estimates should improve.

The program reserves have been distributed to the program managers at the field centers. Although there is both schedule and program risk in this approach, we believe, in the long run, that it will improve program management and operations.

General ABRAHAMSON. As I understand, your $440 million is in reference to numbers that were discussed during your hearings last year; is that correct?

Mr. FLIPPO. Yes, March 1981.

General ABRAHAMSON. I see.

Mr. FLIPPO. Those numbers the agency furnished us.

General ABRAHAMSON. Yes there are several major areas. For example, in the Shuttle budget we have added the filament wound case which is about $60 million. We have added approximately $170 million in terms of spares and equipment. Of course, that is a very important element, again looking out to the operational phase of the program. There are some minuses as well. An important one is some $55 million associated with orbiter modifications and KSC modifications associated with the elimination of the Centaur program. Then, there is a fairly large amount in the space flight operations budget request. Those are some of the main changes since that point in time.

I think we need to provide you very detailed information on this. Perhaps Stan would like to comment on the change in operations.

Dr. WEISS. Yes. I believe I will join General Abrahamson in providing for the record the details on this.

One comment on the presentation of our budget this year. You will note a very large change in the STS operations estimate from fiscal year 1982 to fiscal year 1983. That involves in part the switching of the costs for supporting the launch activity at Kennedy Space Center from the D.D.T. & E. budget to STS operations in bulk. In other words, all of that activity has been moved. In addition, a very large portion of the mission support activity at Johnson has been moved over into the operations side of the budget. So, while there appears to be a monumental change in the operations budget, some of it simply involves an accounting refraction that we are now into the operational area.

We do have some changes from last March's estimate as noted by General Abrahamson. Some of them are derived from our experience obtained from the first two missions concerning KSC launch and JSC mission support manpower; there are significant increases in this area. On the whole, the tank and booster hardware has remained fairly consistent with the figures we had.

Mr. FLIPPO. You mentioned the filament wound case. When is that development needed?

General ABRAHAMSON. That development is needed for the October 1985 launch out of Vandenberg for the first potential Defense Department launch.

Mr. FLIPPO. Has that date been slipping? Changing?

General ABRAHAMSON. Last summer, there was a major reevaluation of the VAFB readiness date within the Air Force, conducted with NASA. I was at least a part of that reevaluation. At

that point, a judgment was made that the date should slip 1 year. Previously, it was scheduled in October 1984, then slipped to 1985.

Mr. FLIPPO. But you believe it is firm now?

General ABRAHAMSON. Yes, sir.

Mr. FLIPPO. Thank you.

Mr. Lowery.

Mr. LOWERY. Thank you, Mr. Chairman.

General Abrahamson, it is good to see you. I am concerned about recent decisions that are going on with IUS and Centaur. I talked to Mr. Beggs yesterday. I have since received a memo from NASA dated today that talks in terms of costs and indicates you have received that as well.

Mr. FLIPPO. Would you present that for the record, Mr. Lowery?

Mr. LOWERY. I would indeed, Mr. Chairman.

[The information follows:]

	Millions
A. IUS	
1. Total (NASA/AF) development costs to complete	650–700
includes 9 vehicles	225–250
2. Sunk costs (NASA/AF)	550–575
3. Costs/copy (buy of 8)	[1]50–60
B. Wide body Centaur:	
1. Total (NASA/AF) development cost to complete (no vehicles included)	[2]230
2. Sunk costs	16
3. Cost/copy (buy of 8)	[1] 35–40

[1] Launched.
[2] Does not include AF unique mode such as secure communication or orbiter mods.

Mr. LOWERY. I guess just as some overview, looking at the costs, noting payload differences, what was the reasoning with OMB and NASA and the Air Force as well in terms of their decisions on IUS.

Is it a shared cost where a bunch of the IUS development costs would be borne by the Air Force? Is that part of NASA's decision? I am having trouble understanding the conclusions reached.

General ABRAHAMSON. Let me make a general statement and then I would ask Mr. Weeks, to go into details.

I would like to say that it was a reluctant decision on the part of both NASA and the Air force to give up what might have been a very appropriate opportunity to move ahead.

As Mr. Beggs explained yesterday, that decision was one that was based on a series of factors from NASA's viewpoint. One of those factors is that the development expenditure for the Centaur, just could not be amortized by NASA across the small number of known missions at this point in time.

On the part of the Air Force, there was a concern that the schedule was, given their experience on IUS, something that had to be looked at very, very carefully in terms of what kind of a commitment. I think the outcome——

Mr. LOWERY. Which schedule are you referring to?

General ABRAHAMSON. The schedule for the development of the Centaur and how that development schedule would meet the initial NASA launches and still allow margin to define requirements for future DOD launches.

Mr. LOWERY. What is the time line that has been submitted for both?

General ABRAHAMSON. NASA needed the schedule to support Galileo. Previously, NASA was working on the long version of Centaur, optimized for Galileo. NASA and the Air Force also examined a shorter, wider version that would be common for both NASA and the Air Force, but the schedule that supported the Galileo mission was determined to be a very tight schedule, a very difficult schedule.

Mr. LOWERY. For IUS?

General ABRAHAMSON. No, for IUS. The IUS schedule is not a problem since the IUS is not completing a development program that is at least technically successful. We have confidence in by virtue of the way that qualification effort is going ahead. However, I believe no one is satisfied with the price projections associated with the IUS. With that, Mike, I would like you to provide some details.

Mr. WEEKS. This is, of course, a fascinating, controversial subject on the upper stages for the space transportation system.

Mr. LOWERY. Yes, I am aware.

Mr. WEEKS. On January 11 a year ago with Dr. Frosch, we had a Saturday meeting to present the detailed pros and cons of how to proceed.

Mr. LOWERY. I am glad somebody is shedding a little light on this subject. [Laughter.]

Mr. WEEKS. I will try to get to the meat of how to proceed on these upper stages, Mr. Lowry, as quickly as possible.

Mr. LOWERY. Are you familiar with this memo?

Mr. WEEKS. Yes, sir; I believe my signature is on it.

Mr. LOWERY. Yes, indeed, it is. [Laughter.]

Mr. WEEKS. Unless somebody is erasing those things quickly, since it was typed this morning, Mr. Lowery.

Mr. LOWERY. Maybe you could run through some of the numbers and some of the rationale, which are even more confusing.

Mr. WEEKS. We made the decision a year ago to proceed with the long, wide-bodied Centaur and started our Lewis Research Center with the four major contractors headed up by General Dynamics, and the other contractors for the platform, the computer, and the engine. We proceeded with that capability, which was a very good capability and very much simplified the Galileo mission and ISPM. We were able to avoid even having kick stages for Centaur. So, we worked from May until about November with the long, wide-bodied Centaur, which is basically a 13,000- to 14,000-pound geosynchronous payload lift capabliity. It does the Galileo and ISPM missions very simply.

Then, we reviewed the options during the upper stage study which we submitted to you in October, signed by Dr. Mark from NASA and Mr. Orr from the Air Force. We were proceeding at that time with the long, wide-bodied Centaur, and, the Air Force was going to continue with IUS's including the full-scale development and follow-on buy of at least four or so of the eight for which they had bought long lead parts. Then, about three DOD missions began to surface that were running into difficult payload weight problems. Length was also a problem for one of them, in particular.

So, we came up with a common DOD/NASA configuration, a short, wide-bodied Centaur, which will deliver a 10,000-pound type

geosynchronous capability. This looked like a practical compromise that could be used for both DOD and NASA. However, it made our mission more complex which, naturally, we didn't like. But as we reviewed the overall national trade-off, the short, wide-bodied Centaur was a prudent thing to do. The next thing is that to do the short, wide-body Centaur, our budget was inadequate in fiscal year 1982 and fiscal year 1983 to execute that program—where you also kept, say, nine out of the IUS full-scale vehicles and, say, four of the follow-on production, and in addition do Galileo and the ISPM on Centaur.

The basic net of it is that within fiscal year 1982 and fiscal year 1983 budget, it was not possible for us within our budget limits to do that short, wide-body Centaur program. We could not find an answer that was also acceptable to the Air Force to meet both cost and schedule constraints. The Air Force had some worries about the delivery schedule of Centaur for their missions, since one of the major options was to stop IUS production at the end of nine. That constituted too much schedule risk in the view of the Air Force, and that is understandable. But, we could meet our date of Galileo mission, which has slipped from an April to a September launch for the short, wide-bodied Centaur. That is when the launch window opens for the short, wide-body Centaur type mission. The reason that the window is different for the short, wide-bodied Centaur is that is it a less performing launch vehicle. It is a 10,000-pound geosynchronous type vehicle. The window has to be governed by an Earth gravity assist mission trajectory, which is doing a big ellipse around the Earth, and then proceeds on to Jupiter after you get this swingby the Earth. That window is in September 1985.

Now to those numbers that are in this morning's memo. We are very indebted to General Randolph getting us the IUS numbers overnight. The wide-bodied Centaur estimate is, of course, ours. We have had a very cooperative, full disclosure on both sides to get numbers in doing these national studies. The Air Force has in the IUS the cost of full-scale development. The reason that that number is $650 million to $700 million is that the $700 million is the cap number on the developments and purchase of nine vehicles.

The IUS has been underway for many years and all nine vehicles now on order are in production at the Boeing plant. In fact, one of them has been delivered to KSC already. As General Abrahamson said, our worries of a year ago about its technical competence have been quite allayed. The software program is fully developed now for their first launch, which is on a Titan III (34-D) and the hardware status which worried us a year ago is in good condition. The main drawback to the IUS, I would say short-term and long-term, is that it is a very expensive recurring cost vehicle.

To my knowledge, no commercial people have at this juncture been willing to get serious about the $50 to $60 million which is what it costs to launch one of those out of the Shuttle.

Mr. LOWERY. Mr. Weeks, the facts have been presented, and correct me if I am wrong, as I understand them. One, we are looking at a capacity difference of about 5,000 pounds lift as opposed to 10,000 to 14,000.

Mr. WEEKS. That is correct.

Mr. LOWERY. Second, this is the first I have heard on schedule and reliability. We are looking at a vehicle, at least the existing version of Centaur that has flown 30 some times and has good reliability. Granted there are modifications being made on the fuel tank. Now I would like to get more into the scheduling problem.

Mr. Chairman, if you would bear with me just a moment.

Mr. FLIPPO. Sure.

Mr. LOWERY. You look at the costs where, according to NASA's numbers the total NASA-Air Force development cost to complete is $650 to $700 million. Of course, that does say it includes nine vehicles. The individual cost as you point out, the recurring costs, $50 to $60 million per copy for IUS compared to wide-bodied Centaur where the development costs are looking at $230 million, half to two-thirds less in development costs, and ongoing costs of $35 to $40 million.

I have trouble understanding how we reached the conclusion that IUS is the way to go. What part of the overall equation is missing that I don't quite comprehend or undertand?

Mr. WEEKS. I think that Mr. Beggs was quite correct in saying that to amortize that $230 million over just our two launches——

Mr. LOWERY. OK. I understand that. I understand it.

Mr. WEEKS. All we can see is in the $15 to $20 million. The two missions—

Mr. LOWERY. I am just talking about overall missions, OK, with the interface that has been taking place for some time with the Shuttle and which is going to continue to take place between NASA and the Air Force.

Let's look at this from a macro sense, not strictly NASA's budget. I have trouble as a guardian of taxpayers' dollars, understanding why this kind of decision is allowed to be made. Because we are talking in terms of overall numbers of flights, not just NASA's, but DOD's and possibly intelligence agencies' flights as well.

If we have got almost triple capacity, if we have got half to two-thirds less cost, we have got almost half the recurring costs in the future, how does one justify going with an IUS?

Mr. WEEKS. I think I will just have to repeat Mr. Beggs' statement of yesterday, that it's very difficult to amortize this——

Mr. LOWREY. Maybe you are suggesting to me I direct these questions to the U.S. Air Force.

General ABRAHAMSON. Since, I guess, I am a representative of both.

Mr. LOWREY. I was hoping you would get the hint.

General ABRAHAMSON. Mr. Weeks knows the entire background back in the early days, sir.

Mr. LOWREY. General, what am I missing?

General ABRAHAMSON. I think what you are missing is that there are rules and regulations about sole source kinds of procurements and differences, which also went into the process. It became one of the decision factors between the two. Additionally, the firmness of the DOD requirements, as you look out into the future, are not fully defined at this point in time in terms of payload.

Mr. LOWREY. General, I appreciate that. But I don't think it takes a Phi Beta Kappa to figure out if you have trouble, the lift capacity for less cost, that is the thing we have been bucking up against all along on the space program——

Mr. FLIPPO. Will the gentlemen yield at that point for clarification purposes only? Would the gentlemen comment on the lift capability of the short wide-bodied Centaur and the IUS?

Mr. WEEKS. Yes, the short wide-body Centaur will basically deliver at least 10,000 pounds to geosynchronous orbit. However, we are not using it in the Galileo or ISPM in that mode. Some of the military missions do use it in that made. The basic capability of the IUS today is 5,000 pounds. Those are fundamentally the differences in energy capability.

Mr. FLIPPO. What mode did you plan to use it, what would be the lift capacity of the mode that you had intended to use?

Mr. WEEKS. Calculations get very complicated because we have to have to consider the velocity when you are going to Jupiter. So, rather than me telling you the weight with the C3, I don't think that is very constructive to do that, Mr. Chairman.

Mr. FLIPPO. Thank you very much.

The gentleman from California.

Mr. LOWERY. Thank you, Mr. Chairman.

Mr. Chairman, to clarify, going to geo-orbit, which I think most of these missions are doing, it's a double capacity with the short body.

Again, if you would continue. My only point is, with double the capacity, sometime in the very, very near term we are going to have need for greater capacity. You know that. I know that. In terms of greater payloads that we can put into space, it's just going to happen. It's going to happen in a very, very short period of time.

General ABRAHAMSON. First of all, I would like to emphasize that this was worked very closely between the Air Force and NASA officials at very high levels as well as at working levels.

Mr. LOWERY. That is well and good. I just have trouble understanding the conclusion. That is what my questions are getting at. What am I missing? You mentioned sole source problems.

General ABRAHAMSON. Yes.

Mr. LOWERY. You mentioned some potential schedule problems. I would like to hear more about that. What else, and maybe we can focus on those and try to get them resolved.

General ABRAHAMSON. Yes, very simply, the risk associated with the schedule is that NASA has a fast schedule that they had to react to. That was it, in order to make the Galileo mission.

One of the concerns stated in the Department of Defense was that because they did not have a full understanding of their future mission requirements, that in fact perhaps some of those requirements that we might drive ahead on the NASA schedule would be either obviated or changed in order to meet some of the Department of Defense requirements.

This would mean that there would be an extended development process. Therefore, because we didn't have the requirements well defined, it was a major question mark. Those questions finally became such that jointly, both agencies felt that this was a wise decision.

An additional outcome is that we should immediately move into a new joint study of upper stage requirements. I can only project what might be the outcome of that, but if, indeed as we define those requirements better which we will be working on that very hard and very quickly, the Centaur shouldn't change in the next few months. If it will become the vehicle that will meet those requirements, then, I think, there may be an opportunity to revisit the question. But, it is a question of economics, technical development, and defining the requirements.

Mr. LOWERY. What are we talking about in terms of Air Force needs for an IUS? How soon do you expect the bird to fly?

General ABRAHAMSON. That is part of the point. That is not defined fully at this time. There were concerns for heavier weight missions as early as 1987, but those are not fully defined yet and can't be discussed at this time.

Mr. LOWERY. I am talking about a two-stage IUS. What is the timetable for those missions to fly?

General ABRAHAMSON. The first IUS will be flown from the Shuttle in January for the TDRSS. But that is the current two-stage version of the IUS.

Mr. LOWERY. Your first mission possibly beyond the, what, nine currently scheduled would be——

General ABRAHAMSON. The first IUS launch on a Titan goes in September. The first IUS Shuttle launch goes in January.

Mr. LOWERY. Beyond the initial nine that I assumed this NASA memo directed itself to would be what, 1987?

Mr. WEEKS. No, the first of the follow-on buy, and I have it here, it's in 1985. TDRSS–E flies in December 1984 which is the fifth one of ours, and that comes out of the follow-on buy.

Mr. LOWERY. Rather than take any more time of the committee here, could I get further information as quickly as possible in terms of this schedule? Let's focus on that in terms of whether these missions will take place, when some of the further follow-up that you are referring to——

General ABRAHAMSON. Yes, sir.

We will be happy to provide what we can and I will also make sure appropriate Air Force representatives provide the information as well.

[The information follows:]

NASA/IUS VEHICLE SCHEDULE

Mission	Vehicle NBR	Production unit	Delivery	Ready to launch
TDRS–A	IUS–1	Full scale development [1]	Sept. 29, 1982	Jan. 20, 1983
TDRS–B	IUS–3	do	Apr. 4, 1983	July 4, 1983
TDRS–C	IUS–7	do	Oct. 20, 1983	Jan. 20, 1984
TDRS–D	IUS–9	FSD/1st follow-on [2]	Feb. 12, 1984	May 12, 1984
TDRS–E	IUS–10	1st follow-on [3]	September 1984	December 1984
TDRS–F	IUS–15	2nd follow-on [4]	September 1986	December 1986
Galileo	IUS–14	do	March 1985	Aug. 14, 1985
ISPM	IUS–13	do	December 1985	May 20, 1986

[1] The first nine vehicles are included in the Full Scale Development Contract.
[2] IUS–9 was initially a three-stage planetary vehicle. The necessary parts to convert to a two-stage configuration are contained in the first follow-on production buy.
[3] Full production go-ahead is expected by June 1, 1982.
[4] Based on planned ATP of January 1983.

Mr. LOWERY. Thank you very much.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Without objection, we would like to include the statement of Mr. Hollenbeck into the record.

[The statement of Mr. Hollenbeck follows:]

OPENING STATEMENT FOR HON. HAROLD C. HOLLENBECK

Thank you, Mr. Chairman. It is indeed a pleasure to welcome Dr. Weiss, and General Abrahamson.

The eyes of the Nation were on Columbia for its maiden voyage on April 12 and we successively on November 12 relaunched the first vehicle ever to return to space. The resounding success of STS-1 and -2, and demonstrations of the Remote Manipulator System and the OSTA-1 payload are quickly proving the viability and reliability of the Space Transportation System.

The Space Shuttle is gradually moving towards operational status, and as it does so, I believe it will be necessary to address a number of new issues. These include:

How effectively will NASA be able to compete with the French-built expendable launch vehicle, Ariane?

In order to stay competitive with Ariane, should we turn over the exclusive marketing rights of foreign and commercial payloads to a private company?

Would a fleet buy of the fourth and fifth orbiters save money for the developing reusable launch system?

Another concern of mine is the militarization of NASA. People outside the agency have told me that over 80 percent of NASA's budget supports programs that relate directly to national security. I would hope that the Department of Defense would come forward with the monies necessary to support their own space projects and not rely on the aeronautics and space agency which is under severe budgetary constraints to perform military R&D.

Following STS-5, we begin the operational phase of the Space Transportation System. We will soon see the development and deployment of the Spacelab—the European-built payload that will house, in a work-sleeve environment, a number of scientific experiments and the mission specialists who will perform their various weightless tasks. We will also see the Tracking Data Relay Satellite become operational, along with a number of other industrial designed satellites and experiments that will begin exploiting the unique capabilities of the shuttle.

One other exciting plan which, I believe, is under the purview of General Abrahamson is the Space Shuttle Involvement Program for Secondary Schools. The industrial-sponsored SSIP-S will allow students to develop experiments that will be flown in the mid-deck storage area of the Shuttle. This idea will foster the enthusiasm that many of our young people have for aerospace. I commend the initiative of this program and look forward to further progress in this area.

Thank you, Mr. Chairman.

Mr. FLIPPO. The next hearing will be Wednesday, February 17, at 10 a.m. in room 2325. We appreciate very much your testimony today. It will be very helpful to us. Thank you very much.

[Whereupon, at 11:10 a.m., the subcommittee was adjourned.]

FIELD HEARINGS

FRIDAY, FEBRUARY 12, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Marshall Space Flight Center, Huntsville, Ala.

TRANSCRIPT OF TESTIMONY

of

DR. W. R. LUCAS
DIRECTOR, GEORGE C. MARSHALL SPACE FLIGHT CENTER

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

of the
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

February 12, 1982

CHAIRMAN FLIPPO: It is great to be here, Dr. Lucas.

DR. LUCAS: Glad to have you.

CHAIRMAN FLIPPO: It is a pleasure to have the full Committee Chairman, Don Fuqua of Florida, with us today. He chaired this subcommittee for a number of years. We are pleased that he could join us. He is still a member of this subcommittee and, like most committee chairmen, he is not too hesitant to do what he wants to do. I am really pleased that he would come and that he continues to have a great interest in the NASA programs.

because there are many demands on his time. Please feel free to proceed as you deem appropriate.

DR. LUCAS: Thank you, Mr. Chairman, Chairman Fuqua, ladies and gentlemen, we are delighted to have you here today. We have had a very busy and very productive year. We think we have accomplished a lot, and we now are honored to have the opportunity to share what we have done and to tell you some of our aspirations for the future. We have supplied a copy of our agenda to the Staff, and I believe you have one before you. If we follow that agenda, our presentations will consist of a Center overview by myself; a report on the Space Shuttle by Bob Lindstrom; a report on the Space Telescope by Fred Speer; and a presentation on Advanced Systems by Bob Marshall. If this meets with your approval, we will proceed in that fashion. If there is any reason for change, we will be glad to do that.

CHAIRMAN FLIPPO: I think this is fine, Bill.

DR. LUCAS: The meeting is being recorded electronically and, of course, we have a stenographer to record what is said for the records of your committee. Our prepared statements, which we request the privilege of submitting for the record, are at your table as are copies of the charts for our presentations today.

In anticipation of your having new subcommittee members visiting Marshall for the first time, we prepared several charts to serve as an introduction to the Center, but inasmuch as you Mr. Chairman and Chairman Fuqua have seen those charts before, I would request permission to leave them in the record and proceed directly to Figure 11. You have seen this organization chart before because the organization has been stable--just as you saw it last year--but we will use this occasion to introduce to you the management people who are present and to mention certain personnel changes that have been made since last year. Jack Lee, the deputy director, is here, and as I mention the names of others, they will identify themselves.

We also have included in the handout a picture organization chart so that you will recognize the people. The Associate Director for the Center was formerly John Potate, but John left us last fall to join an industry on the west coast, and that job is open at this time. The functions are being done by myself and by other members of the staff for the time being. The Executive Staff is headed by Woody Bethay, whom you have met, I believe, and he is also Assistant to the Director. The Safety Office is headed by Dick Henritze who is seated in the back of the room. Our Public Affairs Office is temporarily vacant also, and Woody Bethay is acting in that capacity pending the selection of a new director. Our Chief Counsel, Bill Walsh, left us last fall and went back to Washington to go into the private practice of law. Susan Smith, the deputy chief counsel, is acting in that capacity now, and she isn't here at the moment. The Center Comptroller is Jerry Allen. He is seated near the end of the table, and he is the man who watches all of our resources and keeps us within bounds. The Personnel Office is headed by Don Bean, and the Equal Opportunity Office by Clyde Foster, and I believe Clyde is not in the room at the moment. Our Project Offices operate with a small project staff and gain additional technical resources in a matrix fashion from the Science and Engineering directorate and from the Administration and Program Support directorate. Heading the Shuttle Projects Office is Bob Lindstrom. Later in this hearing, Bob will discuss the Shuttle Projects assigned to Marshall. Bob's responsibilities also include the Michoud Assembly Facility which you will visit tomorrow. The Special Projects Office, which was concerned with the work that we did for the Energy Department, is responsible for the IUS project and a multiplicity

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of small projects, and is headed by Jack Swearingen. Jack is seated at the end of the table. The Space Telescope Project, which you will hear about in some detail later, is headed by Dr. Fred Speer. Materials Processing in Space is headed by Lowell Zoller who is seated near the end of the table; the Spacelab Program Office is headed by John Thomas, and John is also seated near the end of the table. This mark on the corner of the organization box for Spacelab Program Office indicates there has been a change in personnel during the past year. We have appointed as the new deputy director of that office since you were here last, Jerry Richardson. The Spacelab Payload Project Office is headed by Jim Downey. Jim replaced O. C. Jean who retired several months ago.

Program Development is a very small organization that is devoted to the determination of feasibility of new projects and the definition of new projects. That directorate is headed by Bob Marshall, who will speak to you later on Advanced Projects. All of the projects currently assigned to the Project Offices, and some that we have completed, actually began as task teams in the Program Development directorate. The Science and Engineering directorate contains the preponderance of our engineering and science strength, about 1,935 people, and is headed by Jim Kingsbury who is seated at the table. Jim will conduct the tour this afternoon. There have been some changes in Science and Engineering in the last year, primarily movement of people within the laboratories to fill in where retirements and other vacancies occurred. The Director of Administration and Program Support is Jim Murphy, who is seated at the table. His organization provides institutional support for the operation of the Center and program support to

the laboratories and projects.

Figure 12 on educational levels of the work force, is one way to portray the caliber of our people. Of the 3,337 people that we had on board at the end of January, 2,191 held college degrees. Of that number, 105, or a little over 3 percent of our total work force, held the earned doctorate; 417 held at least one master's degree, some of them more than one; and the remainder are at the baccalaureate level. Although we have 1,138 employees who do not have degrees, in many cases their experience fully makes up for the lack of a degree. They are very valuable to our work force. Last summer we were required to reduce our strength by 176 people. We asked for and were granted the privilege of allowing early-out; that is, to allow people to retire earlier than they could voluntarily retire. With the early-out authority, we were able to avoid involuntary separations. As a matter of fact, we received more voluntary retirements than we needed--I think there were about 245--and this enabled us to hire back some beginning engineers that assisted in rebalancing the skills of our work force.

CHAIRMAN FUQUA: How are you affected in this year's budget, Bill?

DR. LUCAS: The reduction for this year plus next year amounts to 100 people. Don, can you split that between years?

MR. BEAN: Yes, that is about 40 this year and 60 next year.

DR. LUCAS: About 40 in FY-82 and 60 in FY-83. That is the way it appears now. At least, that is what has been presented in the budget. The problem we have is in recruiting. Rather than being controlled by the end-of-year strength, we are now controlled by what is called a full-time equivalent. The use of the full-time equivalent affects us this way. If we start the year,

as we did this year and probably will next year, above our full time equivalent ceiling, we have to wait until we are below our ceiling before we can recruit, and then we have still to drop yet lower so that we average out on our full-time equivalent authorization. That can be worked all right except that our ability to recruit does not match the time when we are most likely to be able to hire good people. For example, if we want to hire recent college graduates, we need to begin recruiting seriously in November or December of a given year--which is right at the beginning of our fiscal year--and be essentially completed by about March, because young engineers and scientists who are looking for jobs are placed by that time. So it does give us that problem, but I am sure that we will find ways of dealing with it. Incidentally, our early-out last year did, I think, indicate a concern of many of our people. We anticipated and, in fact, it was verified, that the people who elected to retire were those people within about two years of voluntary retirement, and many of them expressed to us a concern about their future in continuing to work within the Government.

Figure 13 is an outline of our operating plan for FY-82, totaling about 1,377.6 million dollars, broken out by R&D at $1,197.9 million, the C of F at $8.9 million and R&PM at $170.8 million.

CHAIRMAN FLIPPO: How does this compare with the FY-81 budget?

DR. LUCAS: This number in FY-81 was about $1,170 million, I believe--is that right, Jerry?

MR. ALLEN: Yes sir.

CHAIRMAN FLIPPO: And the growth has been in what particular area--has there been growth in one specific area of significance?

DR. LUCAS: This is primarily in the Shuttle operations, isn't it, Jerry?

MR. ALLEN: Shuttle operations, mostly, and Space Telescope.

DR. LUCAS: We have a bit more in Space Telescope this year, and we expect to have more in FY-83. This is a very tight year for Space Telescope.

CHAIRMAN FUQUA: How will '83 total out?

DR. LUCAS: Fiscal '83 according to the budget that has been submitted, runs about $1.7 billion, just a little less than $400 million in addition to 1982. That indicates maturity of programs rather than additive program content because--since we are responsible for the purchase of the External Tanks and the Solid Rocket Boosters--the greater flight rate simply requires that we have more hardware money.

Figure 14 indicates the programs that are assigned to the Center. The first column identifies programs that are approved for implementation. These programs are funded and in progress. The middle column lists those programs that are assigned to the Center for definition. These are, for the most part, projects in Phase B, that is for definition and preliminary design, but not yet approved for implementation. The last column lists projects that are presently undergoing feasibility studies.

Bob Lindstrom will discuss the Shuttle Projects later so I won't discuss them. The progress in those projects has been so substantial and so significant that I wish I could. I think everyone recognizes the progress in terms of the first two launches of the Space Shuttle last year, but sometimes I believe we fail to recognize how much that contributed to the state-of-the-art of rocketry. When one considers that the Space Shuttle

Main Engine is the highest performing engine ever developed and flown; when one considers that the Solid Rocket Boosters were the largest solid rocket boosters ever flown; when one considers that this was the first time that man had ever flown on a vehicle for the first time it was launched--those things remind us of what significant advances in the state-of-the-art were associated with the first two Shuttle launches.

Fred Speer will report on the Space Telescope so I won't cover that program, and Bob Marshall will comment on selected projects assigned for definition and proposed for the future. Each one of these projects is covered in the statements we submitted for the record, and I will now, Mr. Chairman, give you an overview of some of the remaining projects in which we believe you would be interested.

Figure 15 shows the IUS with the TDRS satellite, which is the first IUS launch for NASA. As you know, the IUS is being developed by the Air Force/Space Division. The Boeing Company is the prime contractor, and good progress is being made now on this project. Perhaps if you have not seen the hardware, Figure 16 may give you a better perspective of the stage. It is a two-stage vehicle in which the first stage solid rocket motor weighs about 23,000 pounds. On the lower end is an adapter that attaches to the Titan, if that is the launch vehicle on which it is flown, or attaches to the Shuttle if it is flown from the Shuttle. The interstage joins the first stage to the second stage, which is a somewhat smaller solid rocket stage, weighing about eight and a half thousand pounds. It has an extendable nozzle, which is collapsed in the stack, and upon separation from the interstage, extends to increase the performance of that stage. The

propellant for the two motors is the same, but the specific impulse is some 8 or 10 seconds different between the two. The avionics equipment is at the top of the vehicle near the payload attachment. Figure 17 summarizes the progress of the IUS development being done for NASA. NASA initially had two particular interests, one was a twin-stage vehicle with two stages just like the first one in Figure 16, and the other was a three-stage version which was anticipated for use in some of the planetary programs. The three-stage version was cancelled last February. The two-stage version which we will use is continuing and good progress is being made--substantial progress since a year ago. The first IUS, one that will be launched on Titan, is at the launch site now for checkout, and it will be ready to launch this fall. The first NASA launch will be on STS-6, now targeted for January 1983.

CHAIRMAN FLIPPO: Did you say that the first IUS was already delivered?

DR. LUCAS: Yes sir.

CHAIRMAN FLIPPO: To Kennedy.

DR. LUCAS: Yes, to Kennedy.

CHAIRMAN FLIPPO: What will be the per copy cost of the IUS vehicles, Bill?

DR. LUCAS: Jack, will you answer?

CHAIRMAN FLIPPO: How many is in the first buy?

MR. SWEARINGEN: Mr. Flippo, the first buy would include the development program for the Air Force and NASA, a total of 9 vehicles. There are eight two-stage vehicles, four for the Air Force and four for NASA, and a three-stage vehicle for NASA for planetary, which was cancelled last February. That's the three-stage vehicle to which Dr. Lucas referred, and

it's the ninth IUS. We are now converting, since many of the components are common, that three-stage to a two-stage vehicle. Currently for Air Force and NASA use, we have proceeded to buy long-lead components for follow-on vehicles, and we have placed follow-on procurement for five vehicles for use by NASA and the Air Force. Currently being studied is an enlargement of that procurement, or an additional number, for NASA and the Air Force.

CHAIRMAN FLIPPO: But you have payload commitments for five.

MR. REINARTZ: Correct. Out of the total number of vehicles, we have six TDRS missions for NASA. The last line on Figure 17 shows that NASA has decided to proceed with a planetary mission on a two-stage IUS, which requires very slight modifications. Two vehicles will be needed for that program, so for NASA there are now eight firm missions for the IUS.

CHAIRMAN FLIPPO: And how much of that is for procurement?

MR. REINARTZ: The procurement for both the TDRS and the planetary, on a cost basis--as opposed to new obligations, for '82 for procurement is about $69 million and in '83, we planned costs of $98 million. Because of carryover funds, the obligations will be slightly lower.

DR. LUCAS: Mr. Chairman, that was Stan Reinartz, Manager of the IUS Project, speaking. I failed to see him in the room before and introduce him.

The Spacelab Program I am sure you are thoroughly familiar with because you were at the Cape last week during the delivery ceremonies. You remember that we have the Spacelab Program Office and are the agent of NASA in dealing with the European Space Agency in the development, in the building, and then the delivery of the Spacelab. We also will have a

continuing responsibility for sustaining engineering on the Spacelab, and in another capacity we are working with the payloads to be flown in the Spacelab. The parts shown in Figure 18, the pressurized module and the pallets, can be flown in various combinations, and I think that will come out as I discuss our payload activity. The airlock and tunnel are the U.S.-developed portion of the Spacelab. The igloo is the instrumentation package necessary to be used when we fly the pallet only. Progress on the hardware has been very good. We are pleased with it and are looking forward to its use. Figure 19 shows the Spacelab being unloaded at KSC. We accepted it at the end of last November in Europe, and it was delivered to KSC in December of last year.

Our Spacelab Payload Project Office represents us in the management of the various Spacelab missions. The mission management responsibilities are shown in Figure 20. Very seldom will the Spacelab be filled with one payload. It is a multiple-payload type of laboratory, and often multi-disciplinary. For example, the first mission will carry 36 different experiments. Often, the experimenters are people from universities, or people who do not have the staff or the background to prepare for space flight. Therefore, they need someone to represent their interests to the Space Transportation System—and the Mission Manager does that. He represents the payload user and assists him during the time his payload is conceived, designed, and integrated into the Spacelab, in gathering the data during flight and gathering data subsequent to flight. Figure 21 illustrates Spacelab Mission 1, for which we are the Mission Manager. It is a combination of a pressurized module and a small pallet for experiments

exposed directly to the space environment. The mission, incidentally, is a combination European and U.S. payload and will have two payload specialists, one from the U.S. and one from Europe. We are also the mission manager for Spacelab Mission 2 and, as Figure 22 shows, it is a full pallet payload with all the experiments exposed to the space environment upon the opening of the cargo bay doors. It is primarily an astrophysics payload. Spacelab Mission 3 is again a combination of a pressurized module and a small rack for certain experiments as shown in Figure 23. This one will be largely a zero-gravity or microgravity type payload for materials processing in space and other experiments requiring low gravity. In addition to these three for which we are assigned the mission management role, there is a fourth mission which is primarily a biomedical experiment, and the Johnson Space Center is assigned mission management for that flight on Spacelab. Those are the only four payloads officially assigned at this time. The next one has been assigned to Marshall for definition, and so it is presumed that Marshall will get the next, or fifth payload assignment. Payload mission management requires a very significant amount of effort and a significant amount of knowledge on the part of our engineers. Since Mission Management requires a considerable amount of computer software and knowhow, the Agency has decided it can be done more efficiently if it is concentrated.

In addition to the full payloads missions for which we are responsible, there are also what we refer to as the partial payloads, missions where a small payload or one particular part of a payload is flown on the Orbiter, using perhaps some Spacelab pallets, but not a full Spacelab. The partial payload missions assigned to MSFC are listed on Figure 24. I don't think we

will describe them all but I will give a couple of examples. The OSTA-2 mission will fly on STS-7, and it is a materials processing experiment. The experiment will be carried in a materials experiment assembly (MEA), and it will fly, along with three German experiments on STS-7, and it will fly again on STS-14, and perhaps other flights. Figure 25 shows the MEA and also the three German experiments in materials processing that will be flown. We will have the job of integrating all of those for flight. Figure 26 is an OAST experiment. It is a lightweight solar array which will expand from the cargo bay of the Shuttle into space, and it will test the technology that we have been developing over several years of lightweight, high-efficiency solar arrays.

Now I would like to discuss for a moment another area that I consider to be very important, and this is Materials Processing in Space. I believe this area has great potential, and it has sufficient commercial potential for early application. Figure 27 lists some of the improvements in materials processing that would result from processing materials in space. We have discussed Materials Processing in Space with you before, but just by way of review, it will certainly have at least two advantages; one is that by using the low gravity of space and therefore gaining a simpler experiment model, we will be able to understand better some processes that are going on here on Earth. But in addition to that, we believe that there are many materials that can be processed to great advantage in space, and they are the kinds of materials, solid-state materials, where it is important to distribute one component in a matrix with which it is immiscible. You may have noticed in looking at some of the astronaut pictures from STS-2 and maybe from STS-

1, where they released their flight manuals and the manuals would float in space in the cabin. That is the way these particles will act in a solution. They will remain where you put them, and that it important to us. It is also important that we can solidify without a container and thus avoid the defects introduced by the container during the solidification process. I think one of the most attractive possibilities is what we may do with pharmaceutical materials. Using the technique of electrophoresis we can separate certain pharmaceuticals, some of which cannot be separated at all on Earth, and some which can be separated better in space than on Earth. I want to discuss one of those examples in a moment, but first I want to review the evolution of our materials processing in space program. Figure 28 illustrates that evolution.

We have been doing as much as we can here on Earth. We have a drop tower, as a matter of fact, we have two drop towers. One is located in our structural test operation in Building 4619; it is about 100 feet tall. Another is about 300 feet tall in our Dynamics Test Stand, where you saw the Shuttle stack being dynamically tested. This larger drop tower will allow about four and one-half seconds of very near zero-gravity. We can also get about 30 seconds of low gravity in an airplane flying a parabolic trajectory, and we can get up to six minutes of zero gravity on a sounding rocket, what we call SPAR. We flew only one SPAR mission last year, but it has done a lot in preparing us to understand better and to build the right kind of experiments for Spacelab. The Spacelab will enable us to have more time, up to 6 days or perhaps longer, in the cargo bay of the Shuttle, but ultimately the program points to the utilization of the Space Platform which will open this

activity for commercial applications.

To substantiate to some degree my statement of belief that there is commercial interest in this area, we have two joint endeavors already signed. These are joint endeavors between the Government and private companies with the private company putting up its own money to build the hardware, with the Government flying the hardware, and the company receiving the results of its experiment. Figure 29 lists the joint endeavors active and under consideration. The McDonnell Douglas Company, in collaboration with a pharmaceutical house, Johnson and Johnson, has built a continuous-flow electrophoresis apparatus which was expected to fly first on Spacelab. As it turns out, Spacelab is somewhat delayed and part of the apparatus will fly as early as this summer on the STS-4 on the flight deck of the Orbiter to gain some early experience. We have more recently signed a joint agreement with the GTI Corporation, an electronics firm on the west coast. This firm is going to develop a multichamber furnace and will sell space in that furnace. We have some other prospective joint agreements, one with Microgravity Research Associates that is being reviewed at Headquarters now and will be signed shortly, I believe. We have two other firms, that are not willing for their names to be mentioned now because of certain competitive considerations, that we believe have an interest in a joint venture. Figure 30 indicates a future Spacelab mission and a part of it will fly, as I indicated, on the flight deck of the STS-4 this summer.

In addition to the flight experiments where we have the joint arrangements, we also have collaborative research arrangements with industry. Under these arrangements industrial firms use our facilities such as the drop

tower, and work with our people. Figure 31 lists the kinds of firms that are interested: Deere and Company in the formation of graphite in cast iron. Cast iron has been around a long time, but there is a lot of metallurgy that we don't understand about cast iron and the company is convinced that it can be better understood in the space environment. Apparently Bethlehem Steel joins in that assumption because that firm is also working with us, and we have agreements with DuPont, International Nickel, and TRW. We have some prospective companies that we don't want to identify but who have an interest in the particular areas listed on Figure 31. We offer this to suggest to you that Materials Processing in Space indeed is already attractive to industry and has the potential of becoming even more attractive.

Using Figure 32, I want to describe the purification of pharmaceuticals. There are many pharmaceuticals that have been mentioned as prospects for processing in the space environment, and I hasten to say that I am not an expert in any of them, but I can understand the bottom line of what I believe might be available to us. The one that I would like to talk about has not been proven yet but it is being discussed seriously and I think it has promise: the separation of beta cells. Beta cells are formed in the pancreas and are the cells that produce insulin in the body. There are some 13 million people in the country with diabetes. Three million of them contracted the disease as very young people and can look forward to a total life of insufficiency of insulin in their system, and there are another 10 million who contracted the disease as mature people. These people are treated in various ways but many of them are treated by injections, some of them by daily injections, and I am told that those that have to be injected

daily can spend $15,000 for those injections. There is evidence that the beta cells which produce the insulin can be injected into the human body where they will produce insulin, thus avoiding all these periodic insulin shots that would have to be given to a diabetic for the rest of his life. Now it has already been demonstrated by injecting impure beta cells into animals that it does what it is expected to do, but impurities may cause the body to reject that injection and, therefore, it could be fatal to the animal being used in testing. However, it is believed that, if it can be purified in the space environment, it can be offered to our citizens. I don't know what value can be placed on that, but I am told that in one flight we could produce enough to last a year. It takes but a few pounds to last a year, and I don't know what one who has diabetes would pay for this kind of cure, but I could imagine that many, many Shuttle flights would be paid for, or offset, not to mention the suffering that could be eliminated. I use this as an example that has not yet been proven, but which is sufficiently attractive to be considered.

I will mention now the High Energy Astronomy Observatory, or HEAO. This program is past the hardware stage; as a matter of fact, it is finished. We reported on that last year. The three spacecraft that have been flown, shown in Figure 33, have each by several months exceeded the experimental expectations for which they were designed. HEAO-1 and -3 have reentered and burned in the Earth's atmosphere. HEAO-2 is no longer generating data and it will enter the atmosphere in the not-too-distant future. The evaluation of the data is continuing and we are managing and working with the various principal investigators in the evaluation of that data.

CHAIRMAN FLIPPO: Roughly, Bill, are you talking about a long period of time for the analysis of that data? Is that huge amounts of data that will take a number of years to evaluate?

DR. LUCAS: It won't be a number of years. I think it will take another year or so. As you know the first one flew in 1977, the second one in 1978, and the third one in '79. Jack, do you know if we have completed data evaluation on either mission yet?

MR. SWEARINGEN: No sir, we haven't. For HEAO-1, we are planning to continue the data evaluation through 1983, and for HEAO-2 and -3, through 1984.

DR. LUCAS: So another year or two for evaluation of the data, but many papers have been generated already. We understand that those three spacecraft gave us more knowledge about high energy particles, X-rays, gamma rays and cosmic rays, than existed in human knowledge before that time. HEAO is, we believe, a precursor to the Advanced X-Ray Astrophysics Facility or AXAF. There is great demand among the scientific community that justifies a facility that would operate for a longer period of time. We would like to see AXAF as a new program in the not-too-distant future.

In addition to the kinds of experiments that we have already talked about, we here at Marshall have a substantial element of our Center involved in experiments that are not to be flown on the Spacelab, but on the Orbiter flight deck, or in other places on the Shuttle. There are several listed on Figure 34, and I will not discuss them all. We are working on about 30 experiments inhouse at Marshall now, and we have several others

that we are working on with contractors. The first one shown in Figure 35 is the Induced Environment Contamination Monitor, or the IECM. You may recall that it was flown on STS-2 in the cargo bay, and it will be flown again on STS-3. It remained fixed within the cargo bay and generated good data during the flight of STS-2. In the STS-3 flight, it will be picked up by the manipulator arm and moved outside the cargo bay, to survey the environment around the Orbiter. It is very important to experimenters to understand and have a baseline of the environment in which they expect to work.

The next experiment is the Nighttime-Daytime Optical Survey of Lightning (NOSL). As shown in Figure 36, it is a very low-cost experiment using a camera that was used on Apollo and a tape recorder that was used on ASTP or Skylab. It is small and as you can see it is about like a hand-held camera. Some of our people developed this experiment for the astronauts to use to look down on the clouds and to observe and to take photographs of lightning. The idea of the experiment is that we would analyze that lightning, break the spectrum down into various components, pick out those that would be most sensitive to study later on, and then we develop sensors to be placed on geosynchronous satellites to pick up those significant elements of the spectrum and warn of impending storms . Unfortunately, due to the time available, we didn't get to exercise that experiment much on the flight of STS-2, but we expect to fly it again at a later time.

Figure 37 depicts the last of the projects I want to discuss. We have now phased out entirely of the energy work--NASA-sponsored as well as the DOE energy work. We had three solar energy assignments that we have

93-418 O—82——23

completed or phased out since your last visit to the Center. We had the assignment of developing certain specific solar systems and subsystems for the DOE and that job was completed. We had an assignment to monitor several solar demonstration sites across the country and that job is about 90 percent complete. The third assignment was to represent the DOE in applying solar energy to some 900 or more federal building sites across the country, and we were able to complete, I believe, 90 percent of those. All these efforts have been either completed or turned back to the DOE for further implementation. The particular project I will discuss was a special one and will, I believe, make a significant contribution to the more economical mining of coal. It required development of a guidance and navigation system for automated mining of coal. The rotating drums with the picks, as shown in Figure 37, will grind coal for a long time, but if they grind into the rock overburden, they are worn out almost immediately. The objective was to develop a sensor to guide the drum when it approached the interface between the coal and the overburden. The system will guide the drum around the seam so as not to damage the picks. In addition to that, in a seam which may be 500 feet long or so, there was a tendency for the coal face not to be flat, but to be curved. We provided a guidance and navigation system that kept the seam wall very true. We demonstrated the system in a mine on the 28th of January and phased out of this project. Have we finished the final report, Jack?

MR. SWEARINGEN: In printing.

DR. LUCAS: In printing, so that will be the end of our activity in energy.

Finally, I want to use Figure 38 to illustrate that, in addition to our

various projects, we are engaged in supporting research and technology to the extent that our resources permit. This enables us to support projects that are ongoing, to keep our scientists and engineers sharp, and also make contributions to the common good. The major thrusts that we have in supporting research are in chemical propulsion, large space structures, data systems, and in selected physical sciences. We don't try to cover the full spectrum of science, but we have developed cells of excellence in solar and terrestrial physics, in astrophysics, in X-ray physics, and in materials sciences. This has resulted during the last year in over 260 publications, a total of 60 articles printed in the archive journals and there have been 9 patents awarded for the work that has been done.

CHAIRMAN FLIPPO: Bill, how do you accomplish these primarily? Are these inhouse work, or do you work with contractors, or do you work with universities or a combination of these?

DR. LUCAS: Principally inhouse and with universities but also with some non-profit research institutes. There are occasions where it might be an aerospace industry, but for the most part, they are non-profit research institutes and universities.

CHAIRMAN FLIPPO: Now is this a shrinking area, or is it improving, or it pretty well level?

DR. LUCAS: In total dollars, it has probably shrunk a little but in buying power it has shrunk a great deal. We have a fair amount of dollars. The dollars alone are probably not a good barometer because we have been able to increase somewhat our efforts in chemical propulsion, but that is so expensive that it outweighs some of the other efforts. In the $100,000 to

$200,000 projects, I would say that we have shrunk.

CHAIRMAN FLIPPO: One of the main things that our Committee has been concerned with is, in a decreasing funding atmosphere in Washington, many people have expressed concern about deteriorating our R&D capability. Is this the area that you think they are addressing?

DR. LUCAS: Undoubtedly, this is an area of concern to us because it is an area that isn't essential tomorrow. If you are constrained in budget, you are going to have to give priority to the project that you already have going and have to fly tomorrow and, therefore, you constrain efforts such as supporting research and technology. Figuratively, you eat a little bit of your seed. You are not able to give the attention to future considerations that you would like to. And I think it is an area that does warrant far more support than has received. For example, I think chemical propulsion is well underfunded. For example, when we started the Space Shuttle Main Engine, it was based upon some advanced study work, as a matter of fact, some we had done with SRT money. We had done some work with high-speed turbo pumps, but not nearly enough as came clear as we developed the project. I believe we could have saved time and money, substantial money, had we been able to proceed at the beginning of that project with an adequate amount of supporting research. And I believe now is the time, when we are getting an operational SSME, to think about the next performance step that we want to make in chemical propulsion. There is not very much work being done in that regard. In liquid propulsion, I think NASA is about the only place where work is being done. I believe the DOD is not doing a significant amount of work in liquid propulsion. We have three rocket engine companies

in liquid propulsion, Pratt and Whitney, Rocketdyne, and Aerojet. They are the principal firms for large rockets. Of course, none of them is funded adequately for supporting research and technology. I could say similar things about other areas, but I commented on this one because it demands a very significant amount of funding. In the area of power systems and electronics, we have made some significant progress but there is still much to be done.

Mr. Chairman, that concludes my overview. Unless there are further questions, I will present Bob Lindstrom, the manager of our Shuttle Projects Office, who will discuss the Space Shuttle.

[Figures 1-38 of Dr. Lucas' oral presentation follow:]

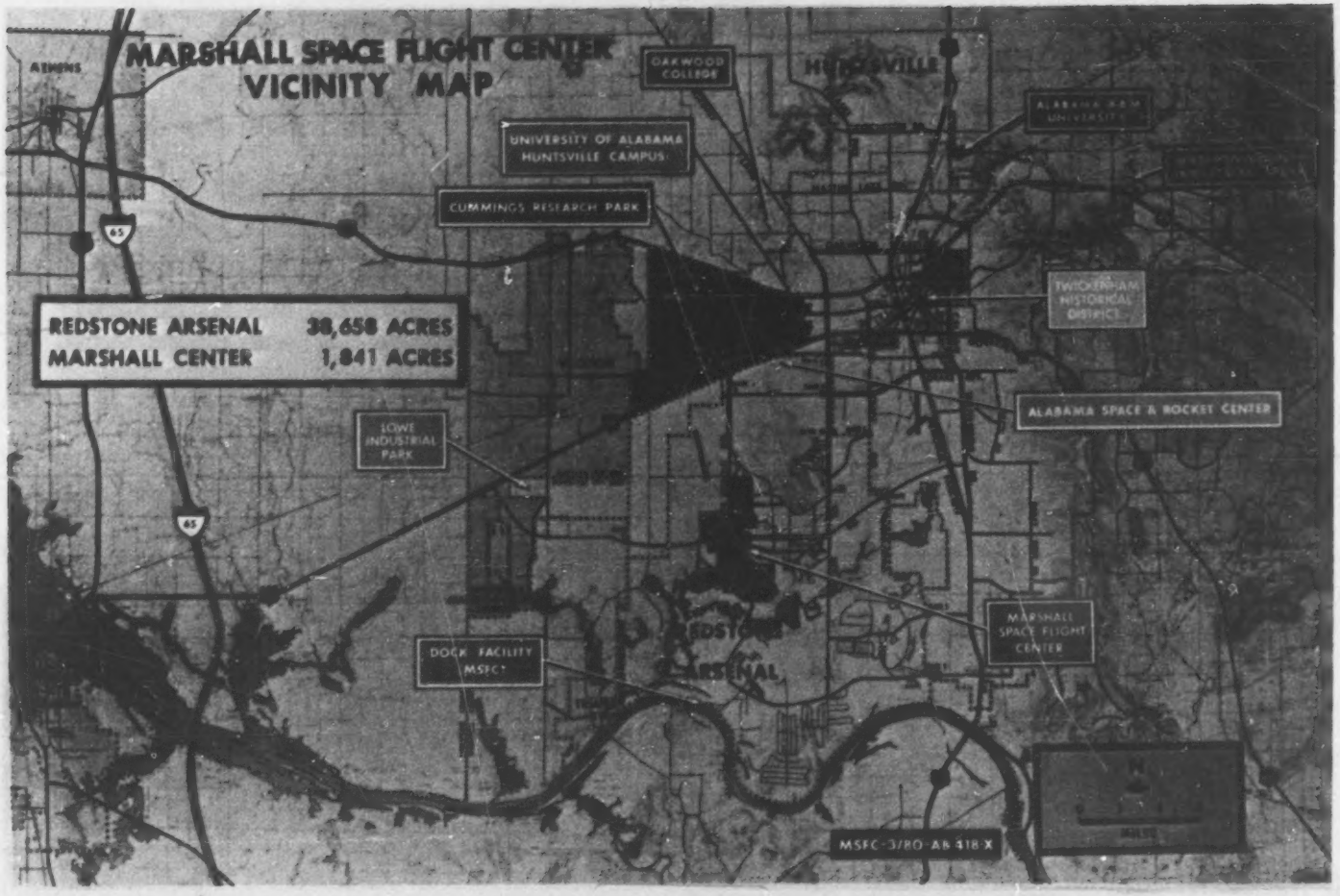

MARSHALL SPACE FLIGHT CENTER
VICINITY MAP
ATHENS
OAKWOOD COLLEGE
HUNTSVILLE
UNIVERSITY OF ALABAMA
HUNTSVILLE CAMPUS
CUMMINGS RESEARCH PARK
REDSTONE ARSENAL 38,658 ACRES
MARSHALL CENTER 1,841 ACRES
TWICKENHAM HISTORICAL DISTRICT
ALABAMA SPACE & ROCKET CENTER
LOWE INDUSTRIAL PARK
MARSHALL SPACE FLIGHT CENTER
DOCK FACILITY MSFC
REDSTONE ARSENAL
MSFC-3/RO-AR-318-X

Figure 1

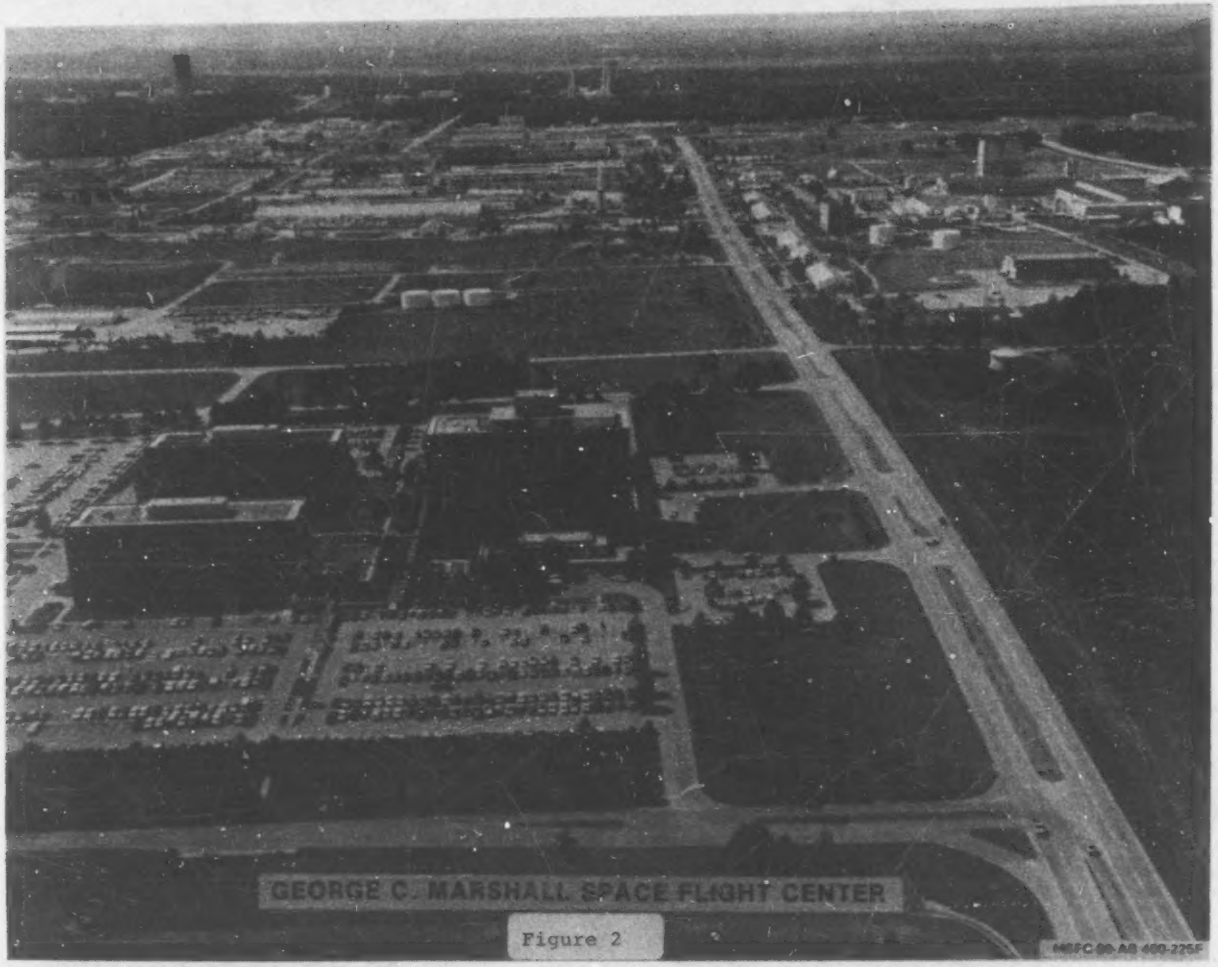


Figure 2

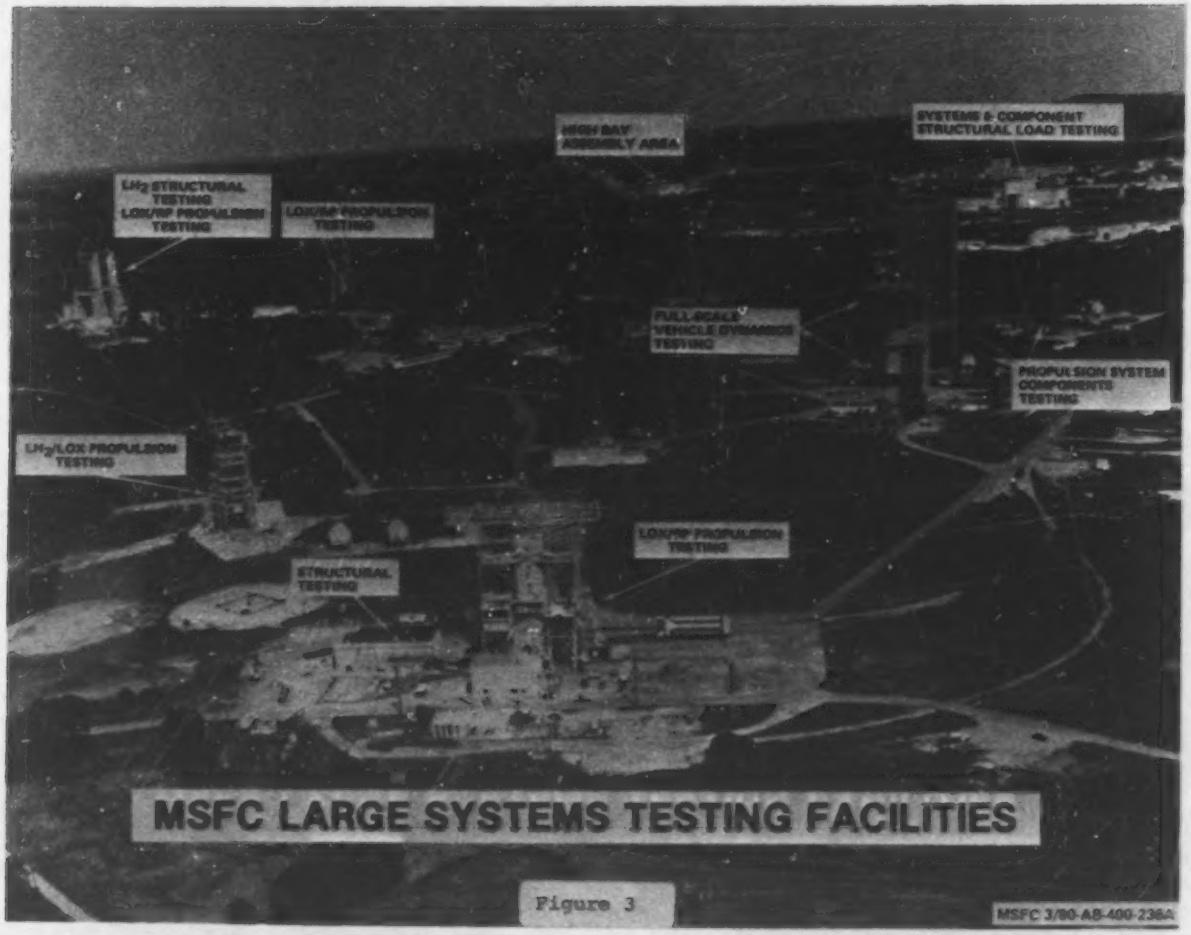

HIGH BAY ASSEMBLY AREA
SYSTEMS & COMPONENT STRUCTURAL LOAD TESTING
LH2 STRUCTURAL TESTING
LOX/RP PROPULSION TESTING
LOX/RP PROPULSION TESTING
FULL-SCALE VEHICLE DYNAMICS TESTING
PROPULSION SYSTEM COMPONENTS TESTING
LH2/LOX PROPULSION TESTING
LOX/RP PROPULSION TESTING
STRUCTURAL TESTING
MSFC LARGE SYSTEMS TESTING FACILITIES
MSFC 3/90-AB-400-236A

Figure 3

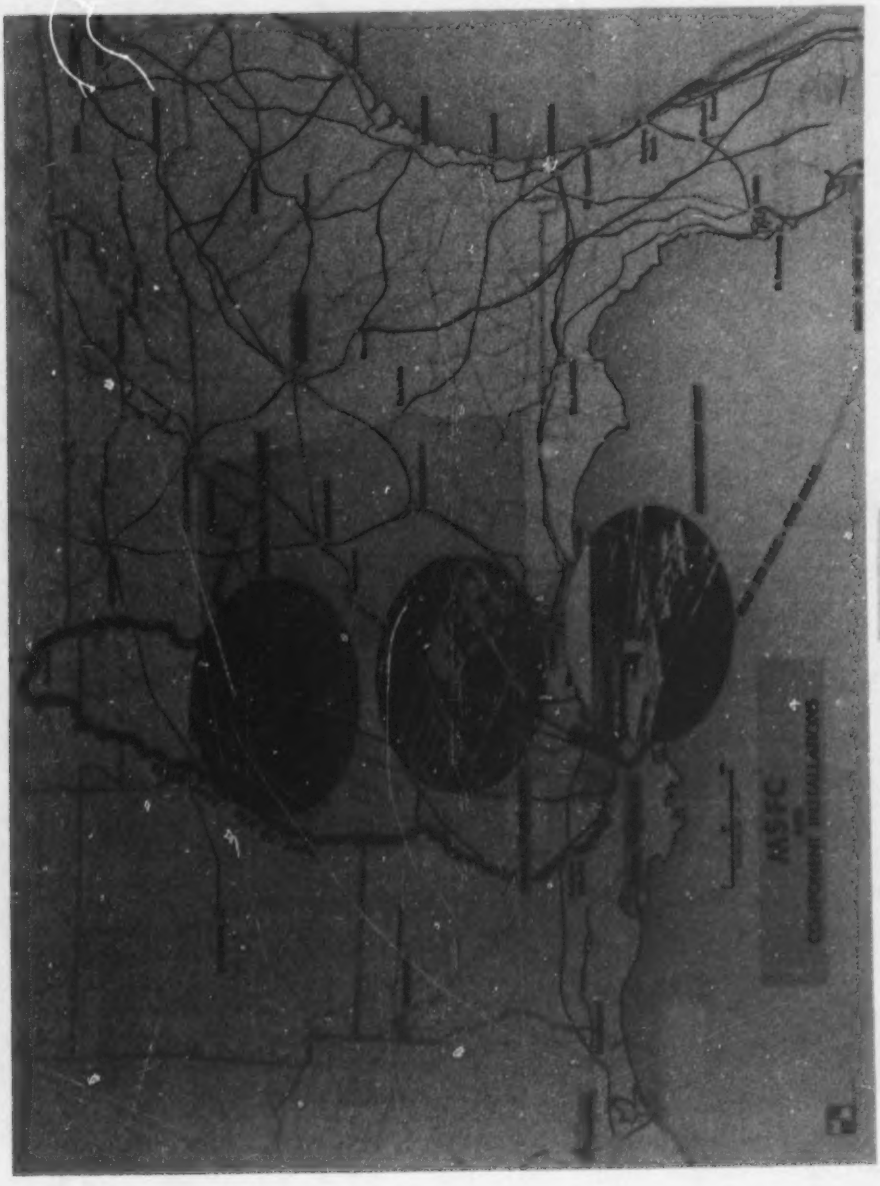


Figure 1

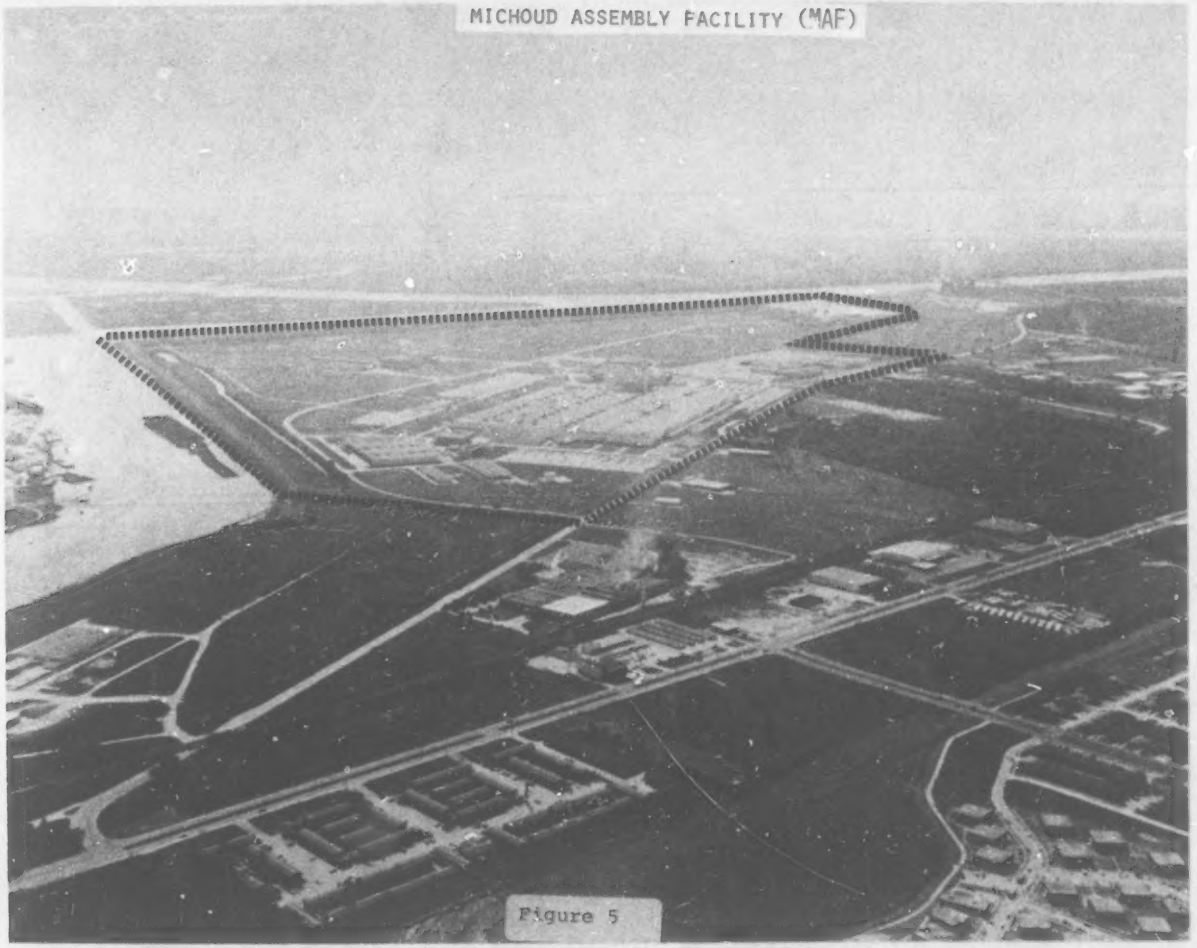


Figure 5

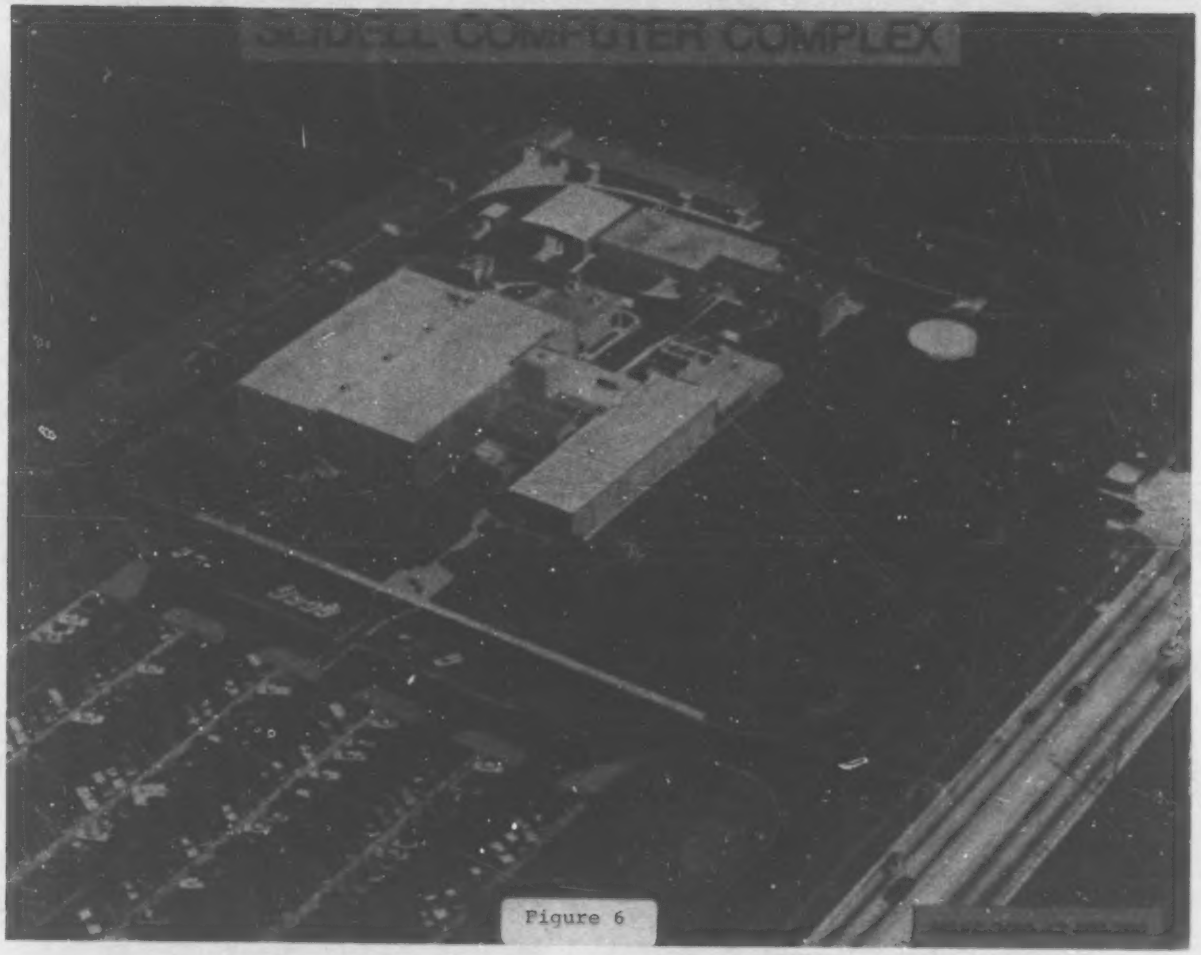


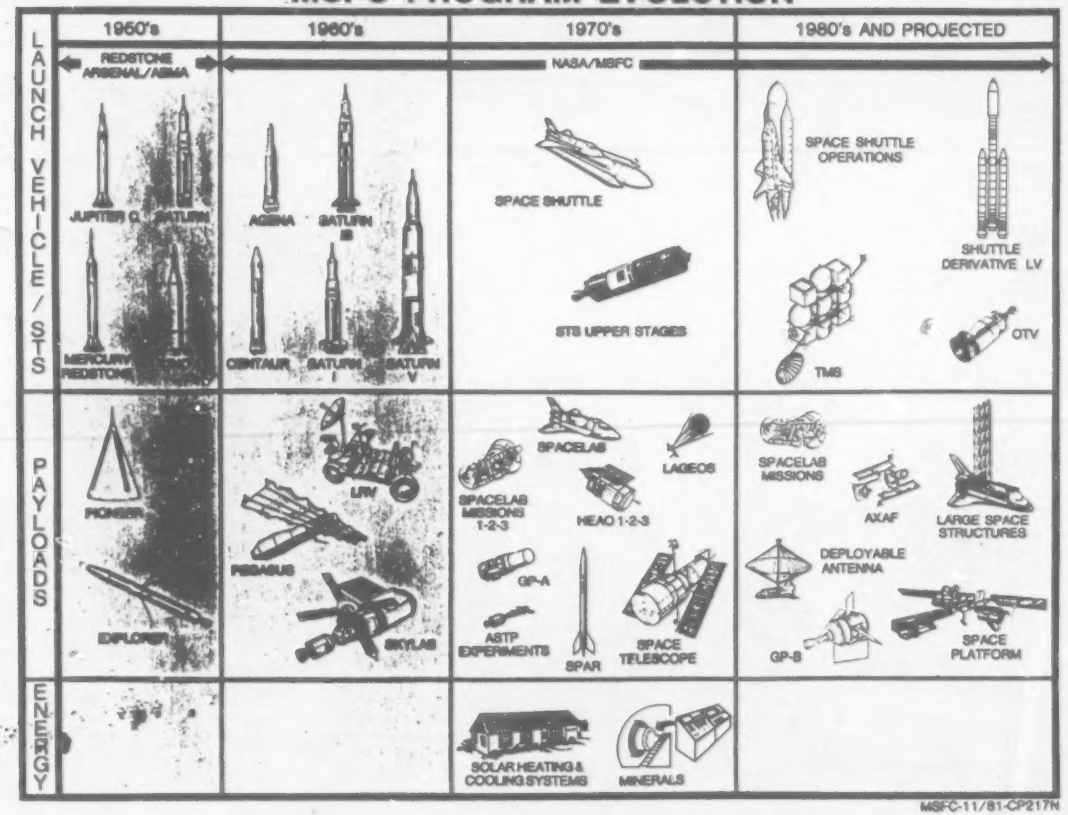
Figure 6

Figure 7

MSFC MAJOR CONTRACT AND RESIDENT OFFICE LOCATIONS

Figure 8

MSFC PROGRAM EVOLUTION



MSFC-11/81-CP217N

Figure 9

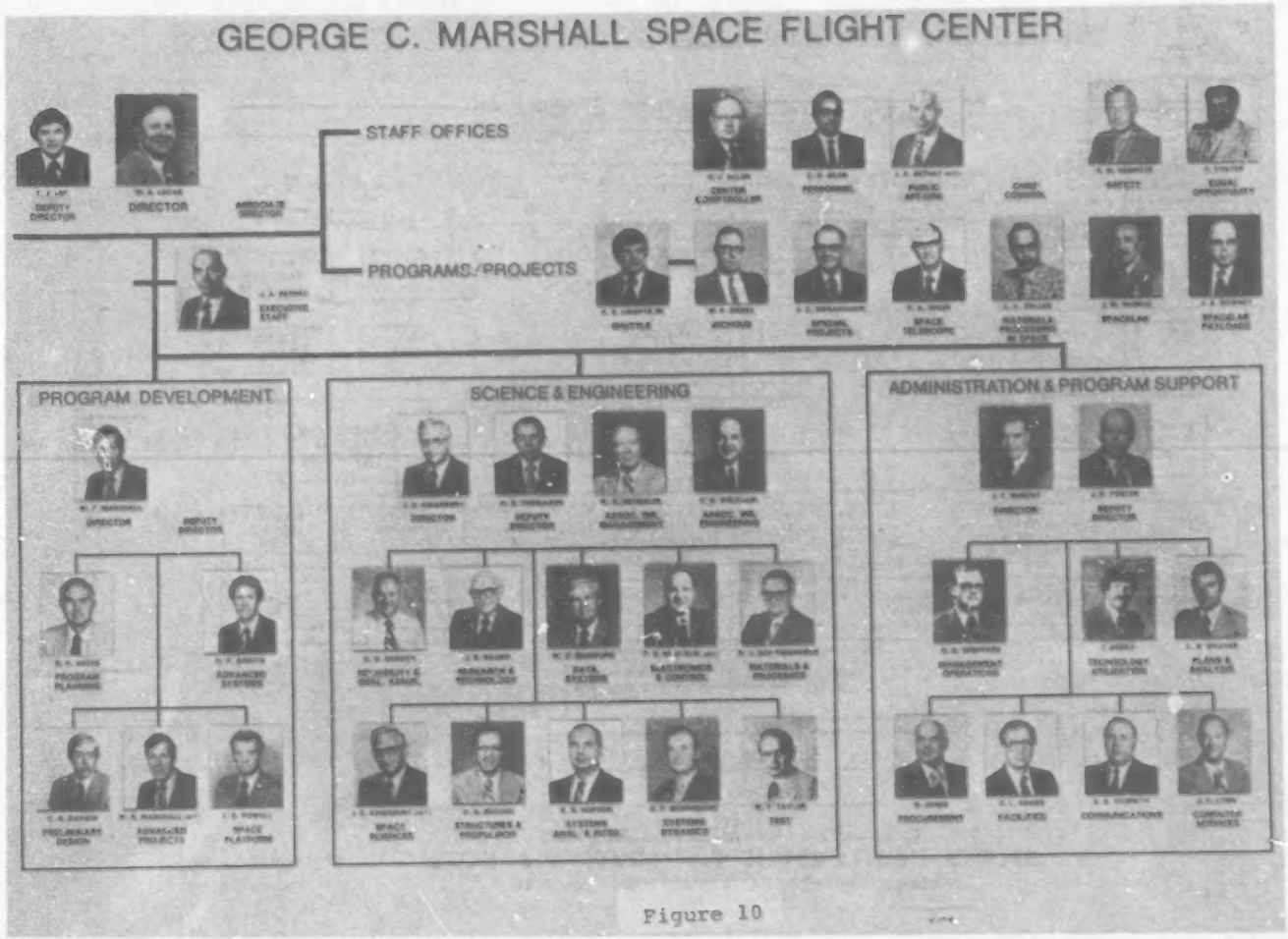

GEORGE C. MARSHALL SPACE FLIGHT CENTER
STAFF OFFICES
PROGRAMS/PROJECTS
PROGRAM DEVELOPMENT
SCIENCE & ENGINEERING
ADMINISTRATION & PROGRAM SUPPORT

Figure 10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

2810-81

GEORGE C. MARSHALL SPACE FLIGHT CENTER

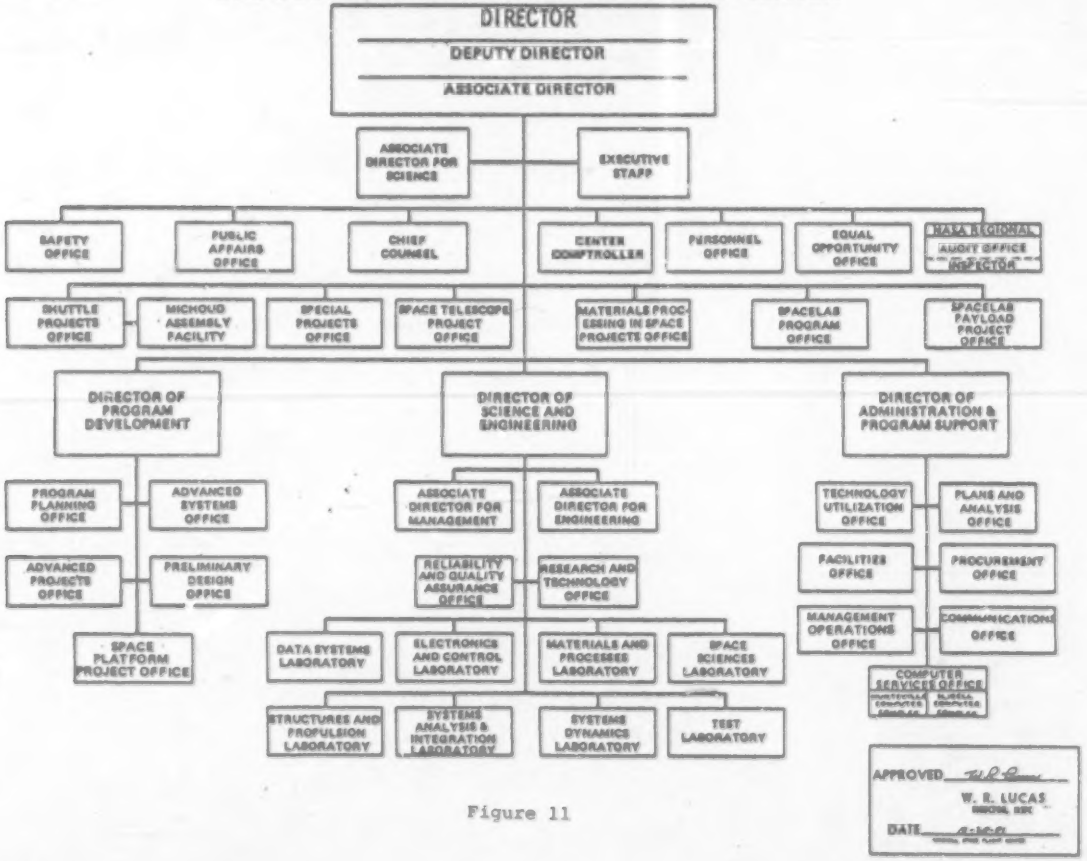


Figure 11

98-418 O—82——24

MSFC EDUCATION LEVELS

● DEGREE LEVEL	2199
- DOCTORATE	105
- MASTERS	417
- BACCALAUREATE	1677
● NON-DEGREES	1138
- TECHNICIANS	381
- CLERICAL	482
- ADMINISTRATIVE SPECIALIST AND NON-DEGREE ENGINEERS	275

JANUARY 1982

Figure 12

MSFC
FY-82 BUDGET
(NOA $M)

R&D	1197.9
SHUTTLE (DDT&E/PROD.)	473.0
SPACE FLIGHT OPERATIONS (INCLUDES SHUTTLE OPS, SPACELAB, & IUS)	528.9
SPACE TELESCOPE	134.7
MATERIALS PROCESSING IN SPACE/SRT	19.2
PAYLOADS AND RESEARCH & TECHNOLOGY	42.1
C OF F	8.9
R&PM	170.8
TOTAL	1377.6

Figure 13

MSFC PROGRAM/PROJECT ACTIVITY

603–80

2/10/82

APPROVED FOR IMPLEMENTATION	ASSIGNED FOR DEFINITION	PROPOSED FOR FUTURE
● SPACE SHUTTLE – MAIN ENGINE – EXTERNAL TANK – SOLID ROCKET BOOSTER – SYSTEMS ANALYSIS, TEST & INTEGRATION		● SOLID ROCKET BOOSTER UNMANNED LAUNCH VEHICLE (SRB–X) ● SHUTTLE DERIVED LAUNCH VEHICLES
● STS OPERATIONS	● SPACE PLATFORM	● SCIENCE AND APPLICATIONS SPACE PLATFORMS ● GEOSTATIONARY PLATFORM
● INERTIAL UPPER STAGE		● ORBITAL TRANSFER VEHICLE ● TELEOPERATOR MANEUVERING SYSTEM
● SPACELAB	● TETHERED SATELLITE SYSTEM	
● SPACELAB P/L MISSION MGMT		● DEPLOYABLE ANTENNA FLIGHT EXPERIMENT
● MATERIALS PROCESSING – EXPERIMENT DEVELOPMENT – PRECURSOR EXPERIMENTS – SPACE SHUTTLE PAYLOADS		● LARGE SPACE STRUCTURES ENGINEERING
● HIGH ENERGY ASTRONOMY OBSERVATORIES	● ADVANCED X–RAY ASTROPHYSICS FACILITY (AXAF)	● SOLAR TERRESTRIAL OBSERVATORY ● PIN HOLE OCCULTER
● SPACE TELESCOPE		
● FLIGHT EXPERIMENTS	● GRAVITY PROBE B(GP–B)	
● SUPPORTING RESEARCH AND TECHNOLOGY		

Figure 14

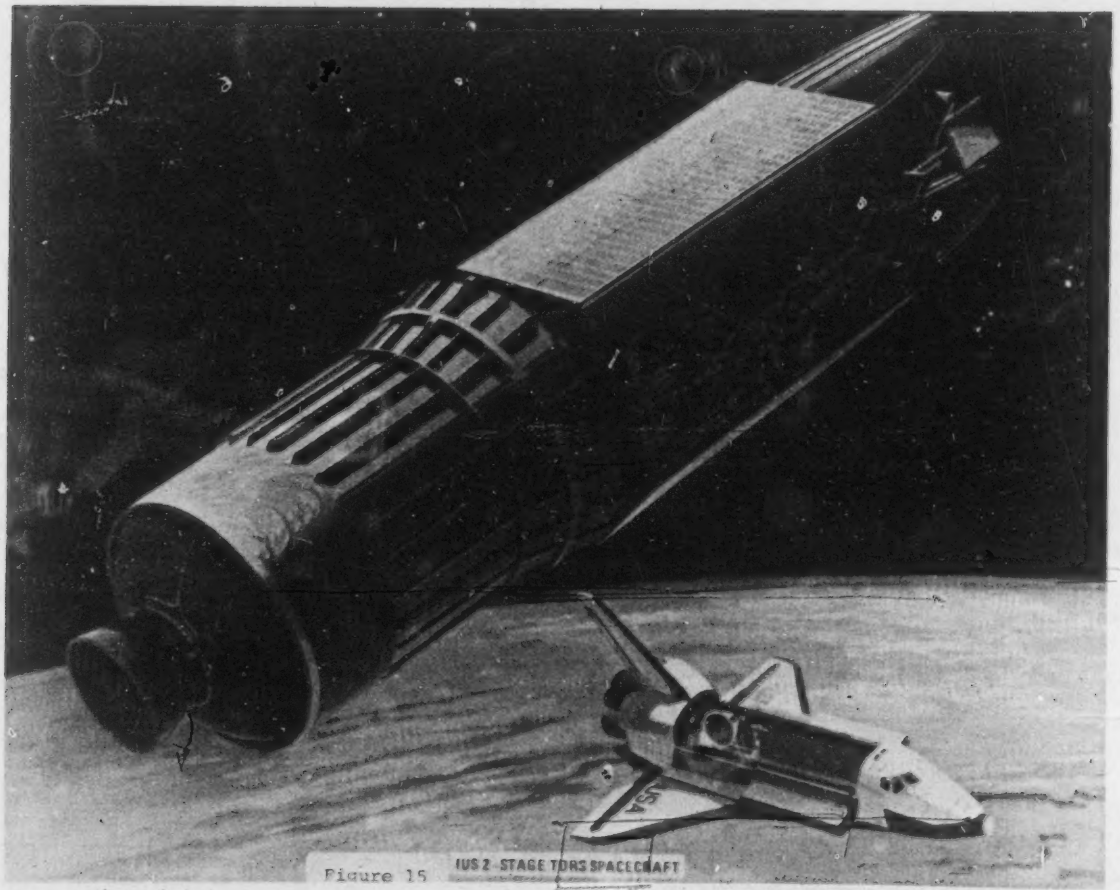


Figure 15 IUS 2-STAGE TDRS SPACECRAFT

IUS TWO-STAGE VEHICLE

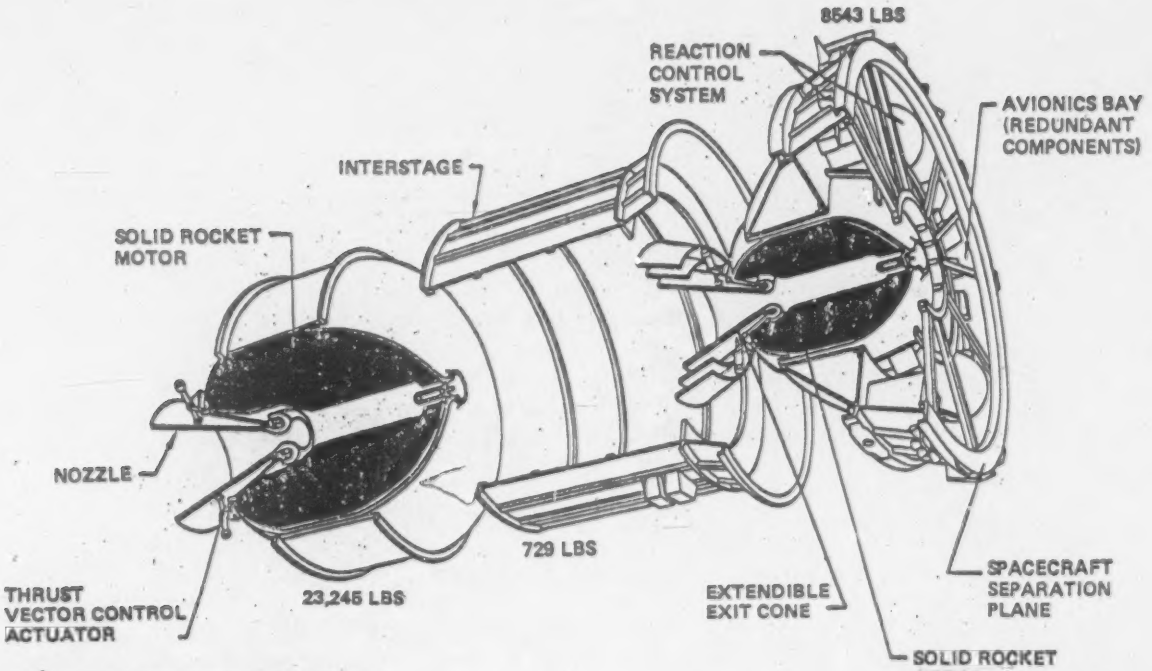


Figure 16

IUS Three-Stage Development Activity Cancelled February 1981

IUS Two-Stage Development, Manufacturing and Testing Proceeding On Schedule For NASA TDRS Missions (Communication Satellites)

- Component And System Qualification Testing Is 95 Percent Complete
- Flight-Type Facility Checkout (Pathfinder) Vehicles For Titan And Shuttle Use Are In Test At ELS And KSC
- First Titan Flight IUS In Launch Site Checkout
- First NASA Shuttle Flight IUS In Final Testing At Boeing/Seattle
- First IUS/TDRS Launch On STS-6 – January 1983

NASA Proceeding With Galileo Mission On A Two-Stage IUS – Launch August 1985

Figure 17

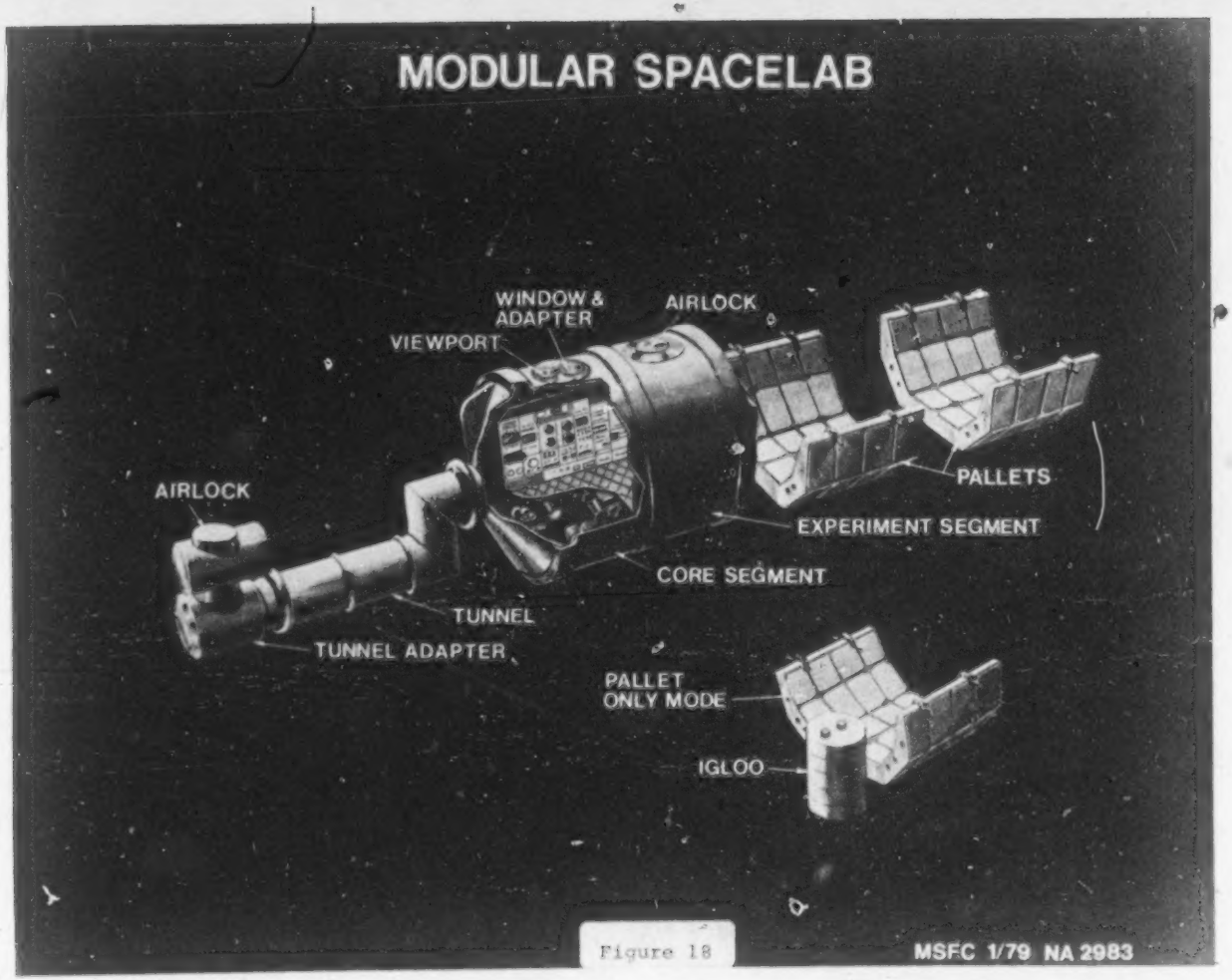

MODULAR SPACELAB
WINDOW & ADAPTER
VIEWPORT
AIRLOCK
AIRLOCK
PALLETS
EXPERIMENT SEGMENT
CORE SEGMENT
TUNNEL
TUNNEL ADAPTER
PALLET ONLY MODE
IGLOO
MSFC 1/79 NA 2983

Figure 18

SPACELAB FLIGHT UNIT 1 UNLOADING AT KSC
esa
spacelab
ERNO
NA-82-2643

Figure 19

SPACELAB PAYLOAD MISSION MANAGEMENT

- Represent the payload user community in the utilization of the STS.
- Responsibilities for payload aspects of the mission include:
  - -- Mission planning and definition
  - -- Interfaces between mission elements
  - -- Schedules and budgeting
  - -- Mission integration
  - -- Real time mission execution

Figure 20

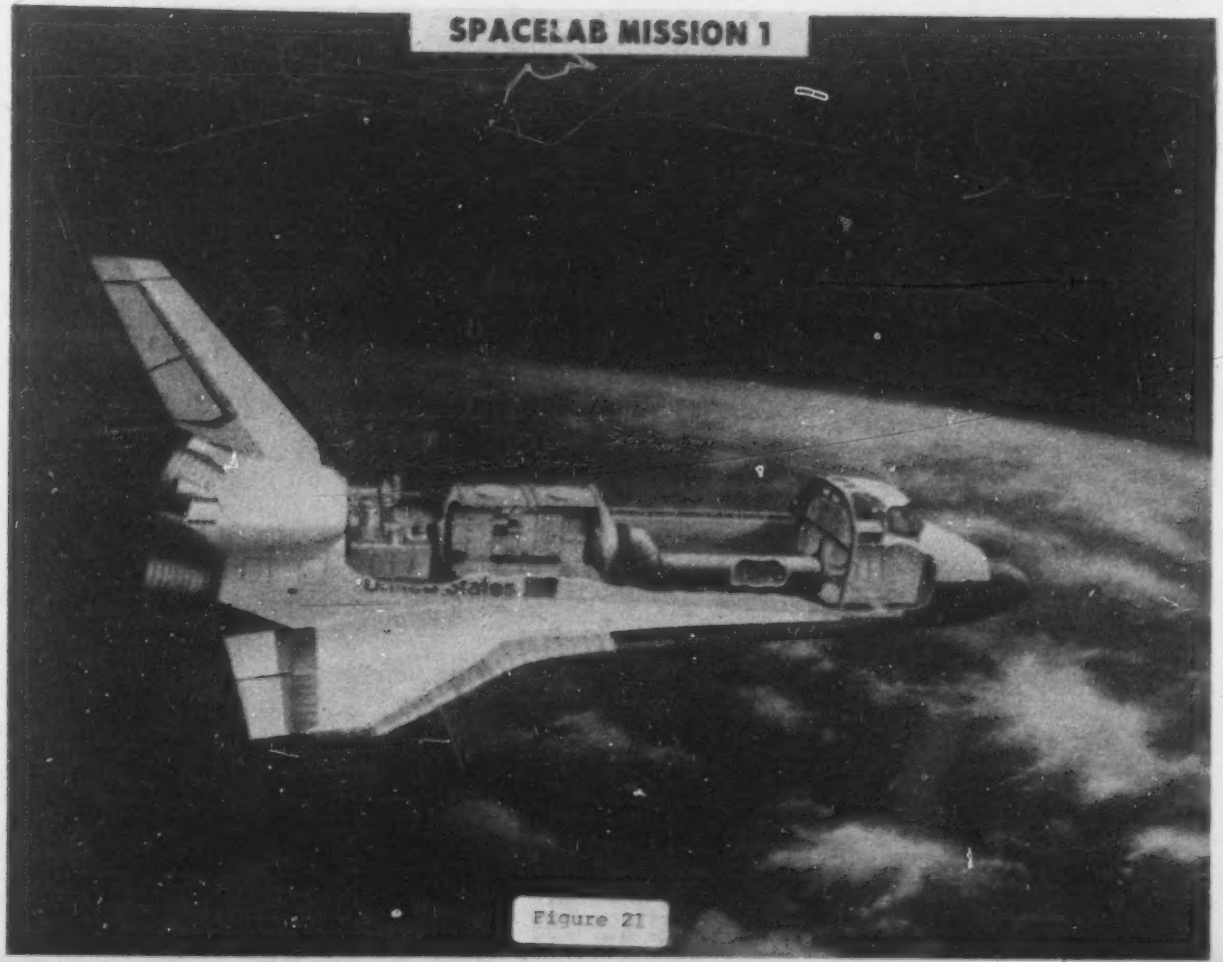


Figure 21

Figure 22

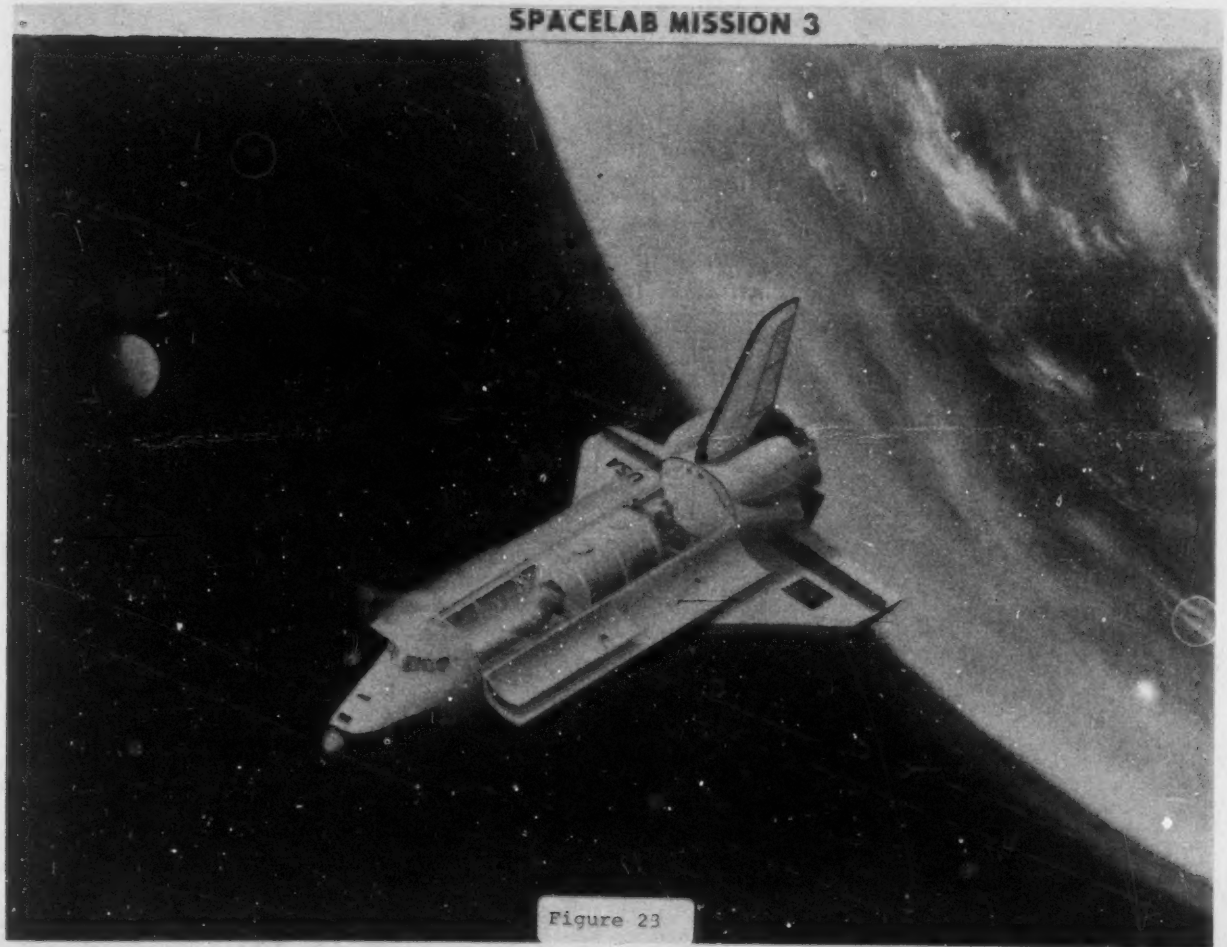


Figure 23

PARTIAL PAYLOAD MISSIONS
ASSIGNED TO MSFC

MISSION	
OSTA-2 (STS-7)	Materials Processing Experiments (MEA-A1 and Three German Materials Processing Experiments) on Special Support Structure
OAST-1 (STS-14)	Light Weight Solar Array/Large Space Structures Technology on Special Support Structure
MEA-1 (STS-14)	Materials Processing Experiments Reflight from OSTA-2 on Special Support Structure. (MEA-A2 and Three Experiment Systems for GAS Cannisters)
MPS-1 (STS-35)	Materials Processing in Space Mission on an OFT Pallet System
OSS-3 (STS-24)	UV Astronomy Mission on Spacelab/Pallet (Integration and Operation Support to GSFC Mission Manager)

Figure 24

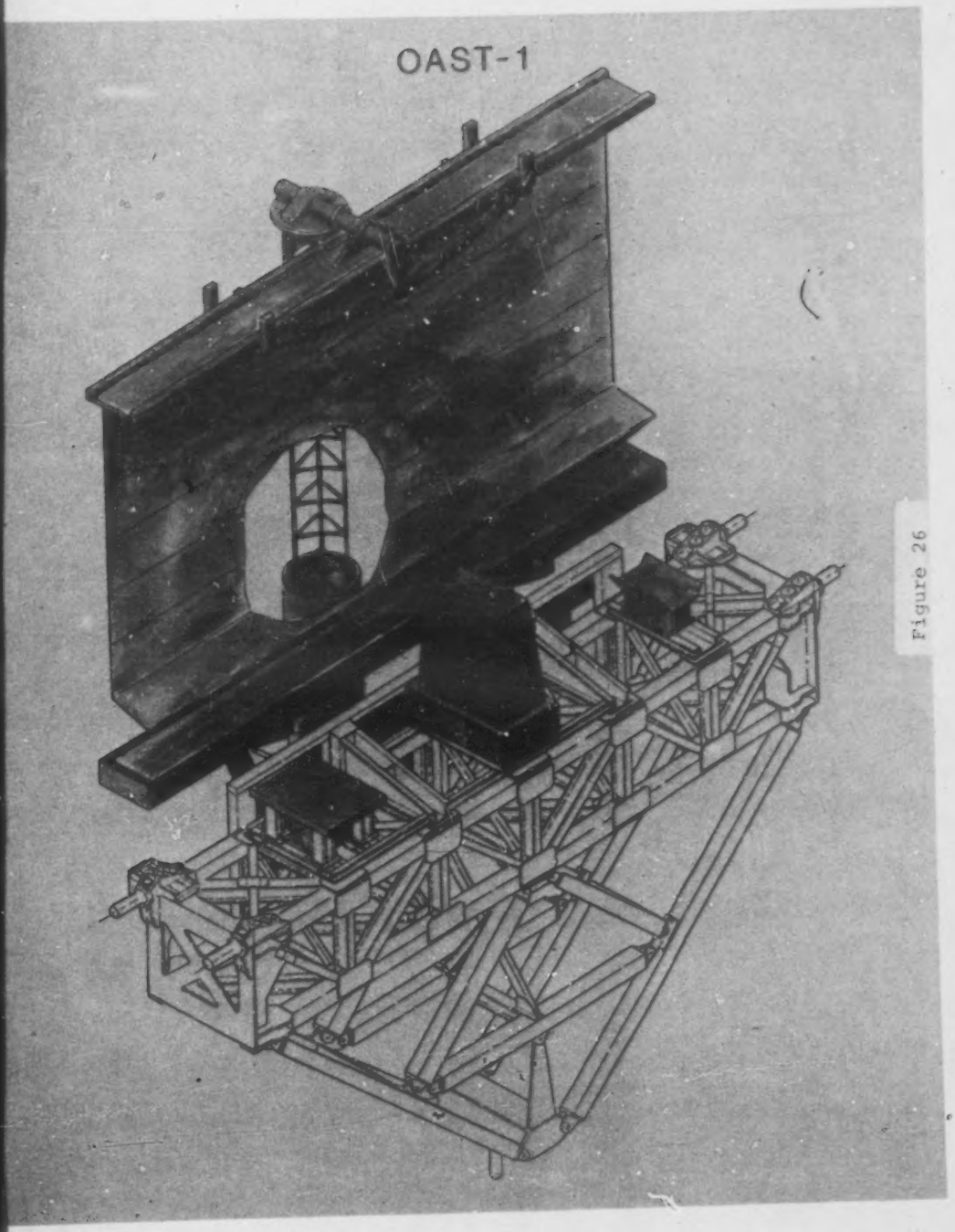


Figure 26

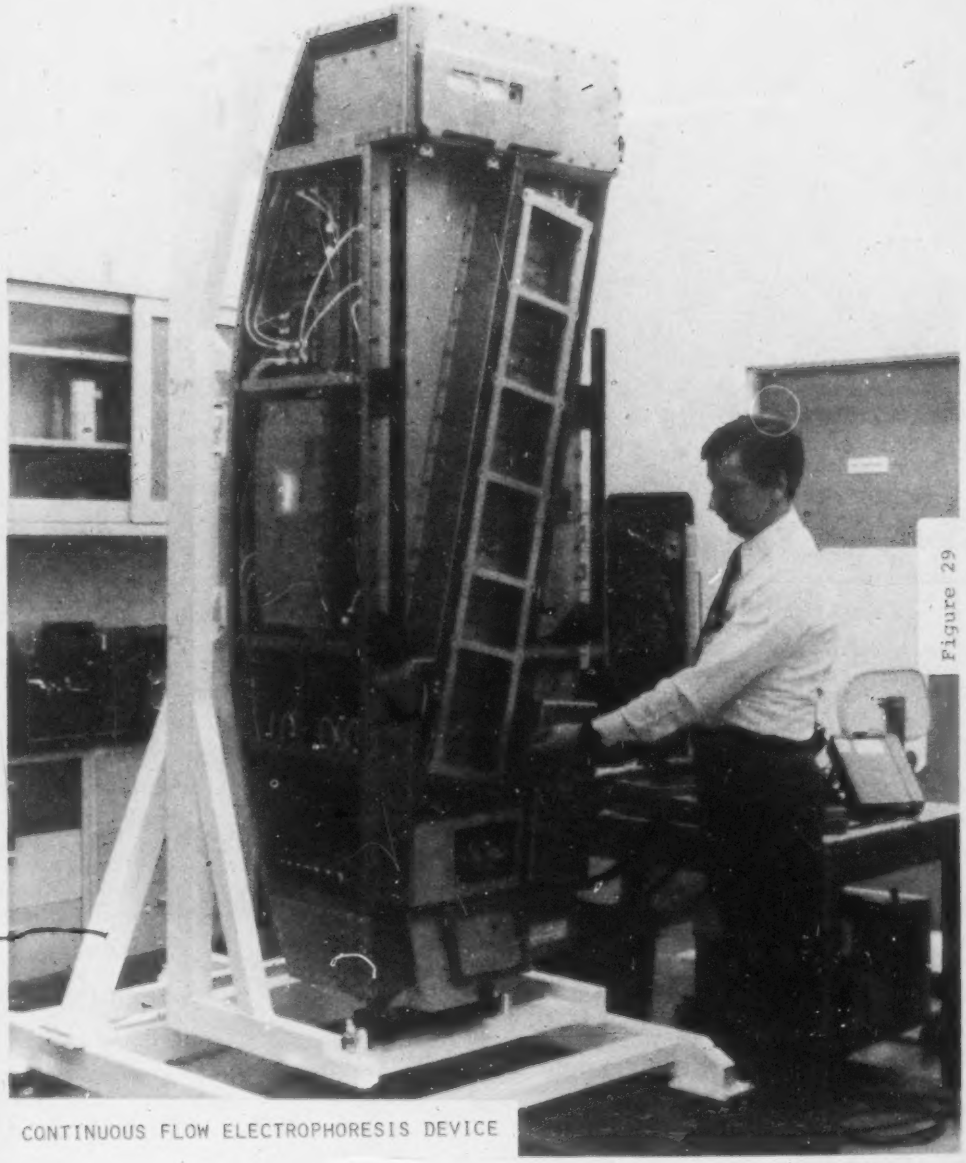


Figure 29

CONTINUOUS FLOW ELECTROPHORESIS DEVICE

MATERIALS PROCESSING IN SPACE

PURIFICATION OF PHARMACEUTICALS

Figure 31

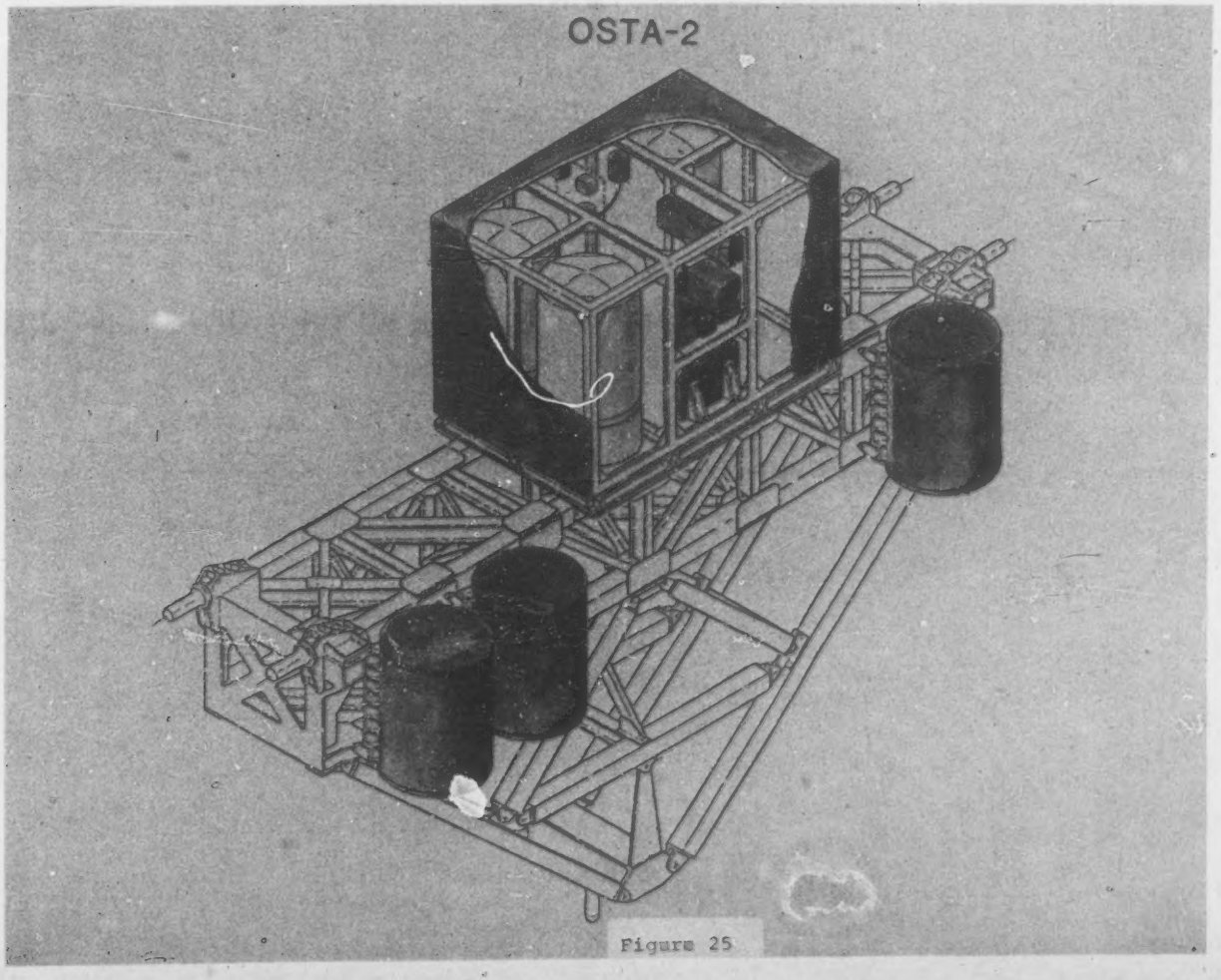


Figure 25

3274-81

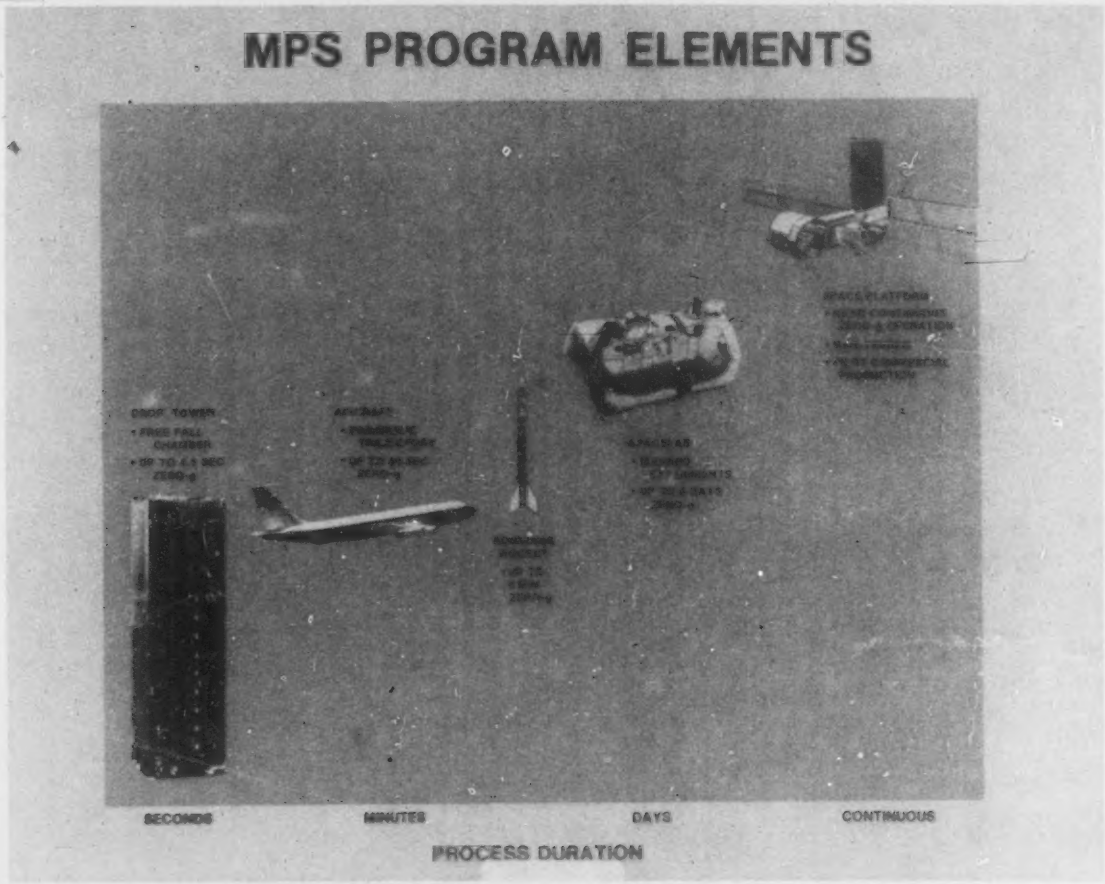
THE ABSENCE IN SPACE OF GRAVITY-INDUCED PHENOMENA CAN LEAD TO

- IMPROVEMENTS IN PROCESSES USED ON EARTH
- COMMERCIAL PROCESSING OF MATERIALS IN SPACE

- LARGER & BETTER CRYSTALS
- IMPROVED METALS & COMPOSITES
- NEW & IMPROVED PHARMACEUTICALS

Figure 27

93-418 O—82——25


MPS PROGRAM ELEMENTS
SECONDS
MINUTES
DAYS
CONTINUOUS
PROCESS DURATION

MATERIALS PROCESSING IN SPACE

JOINT ENDEAVOR AGREEMENTS (JEA's)

COMPANY	AREA OF INTEREST	STATUS
ACTIVE		
MCDONNELL-DOUGLAS ASTRONAUTICS COMPANY	CONTINUOUS FLOW ELECTROPHORESIS	JEA SIGNED 1-25-80
GTI CORPORATION	MULTICHAMBER ALLOY SOLIDIFICATION FURNACE SYSTEM	JEA SIGNED 1-20-82
PROSPECTIVE		
MICROGRAVITY RESEARCH ASSOCIATES	CRYSTAL GROWTH IN LOW GRAVITY	JEA BEING REVIEWED AT HEADQUARTERS
TWO FIRMS	SEPARATION OF PHARMACEUTICAL MATERIALS	INITIAL INQUIRY

Figure 30

MATERIALS PROCESSING IN SPACE

CURRENT COLLABORATIVE RESEARCH WITH INDUSTRY

COMPANY	AREA OF INTEREST
DEERE AND COMPANY	FORMATION OF GRAPHITE IN CAST IRON
BETHLEHEM STEEL CORP.	SOLIDIFICATION OF CAST IRON
DU PONT	CATALYST MATERIALS
INCO R&D CENTER	THEORY OF ELECTROPLATING
TRW EQUIPMENT DIVISION	POROSITY FORMATION IN CASTINGS

PROSPECTIVE COLLABORATIVE RESEARCH WITH INDUSTRY

- IMPROVED MATERIALS FOR ELECTRICAL CONTACTS
- RESEARCH ON TRANSITION OF COAL TO COKE
- CRYSTAL GROWTH (Hg-Cd-Te)
- GLASS FORMING ALLOY SYSTEMS (Eg. Cu-Zr)
- FURNACE SYSTEMS

Figure 32

HIGH ENERGY ASTRONOMY OBSERVATORY
HEAO 1
HEAO 2
HEAO 3
MSFC-80-HA-1720C

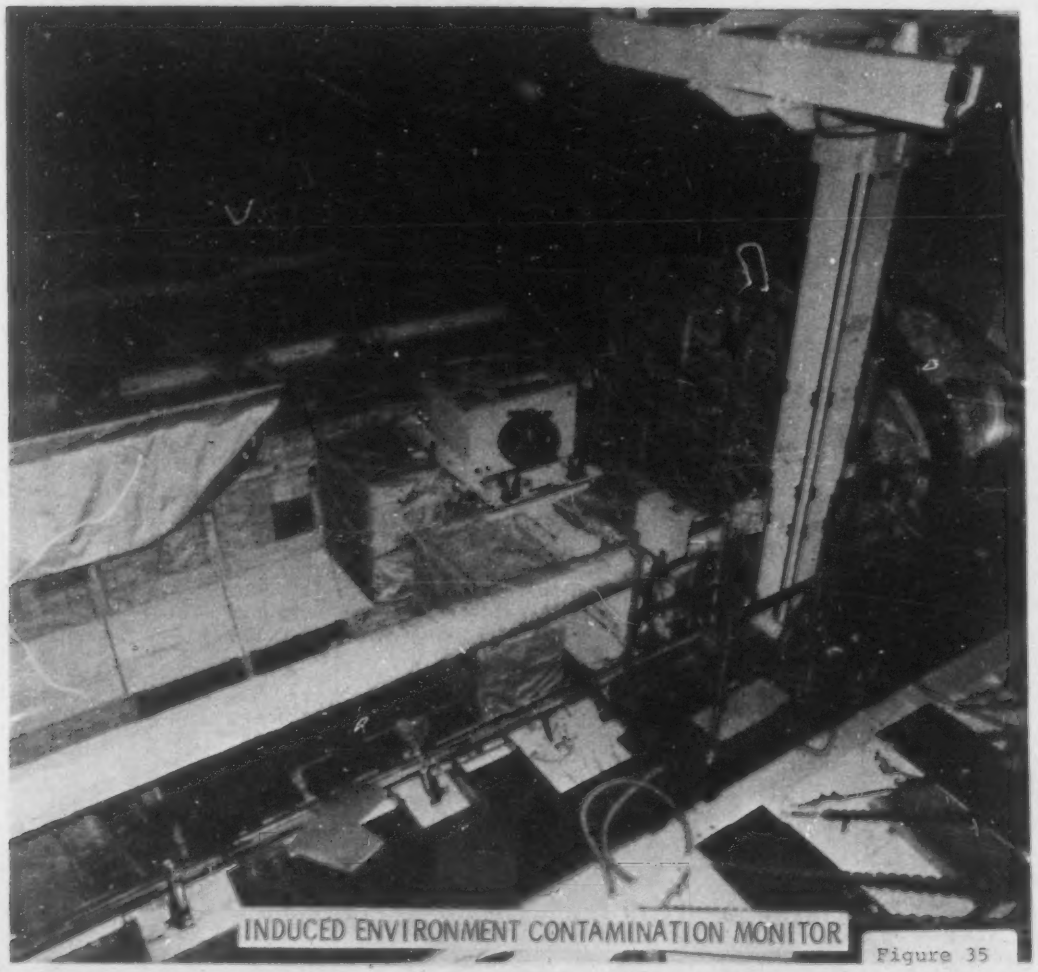
Figure 33

MSFC EXPERIMENTS

STS-2	--	Induced Environment Contamination Monitor
	--	Nighttime-Daytime Optical Survey of Lightning
STS-3	--	Orbital Flight Test with OSS-1 payload
	--	Induced Environment Contamination Monitor
	--	Monodisperse Latex Reactor
	--	Electrophoresis Engineering Verification Test
	--	Retarding Potential Analyzer/Differential Ion Flux Probe
STS-4	--	Induced Environment Contamination Monitor
	--	Nighttime-Daytime Optical Survey of Lightning
	--	Monodisperse Latex Reactor
	--	Continuous Flow Electrophoresis System
STS-5	--	Monodisperse Latex Reactor
STS-6	--	Monodisperse Latex Reactor
	--	Electrophoresis Engineering Verification Test
	--	Continuous Flow Electrophoresis System
STS-7	--	Continuous Flow Electrophoresis System
STS-8	--	Continuous Flow Electrophoresis System

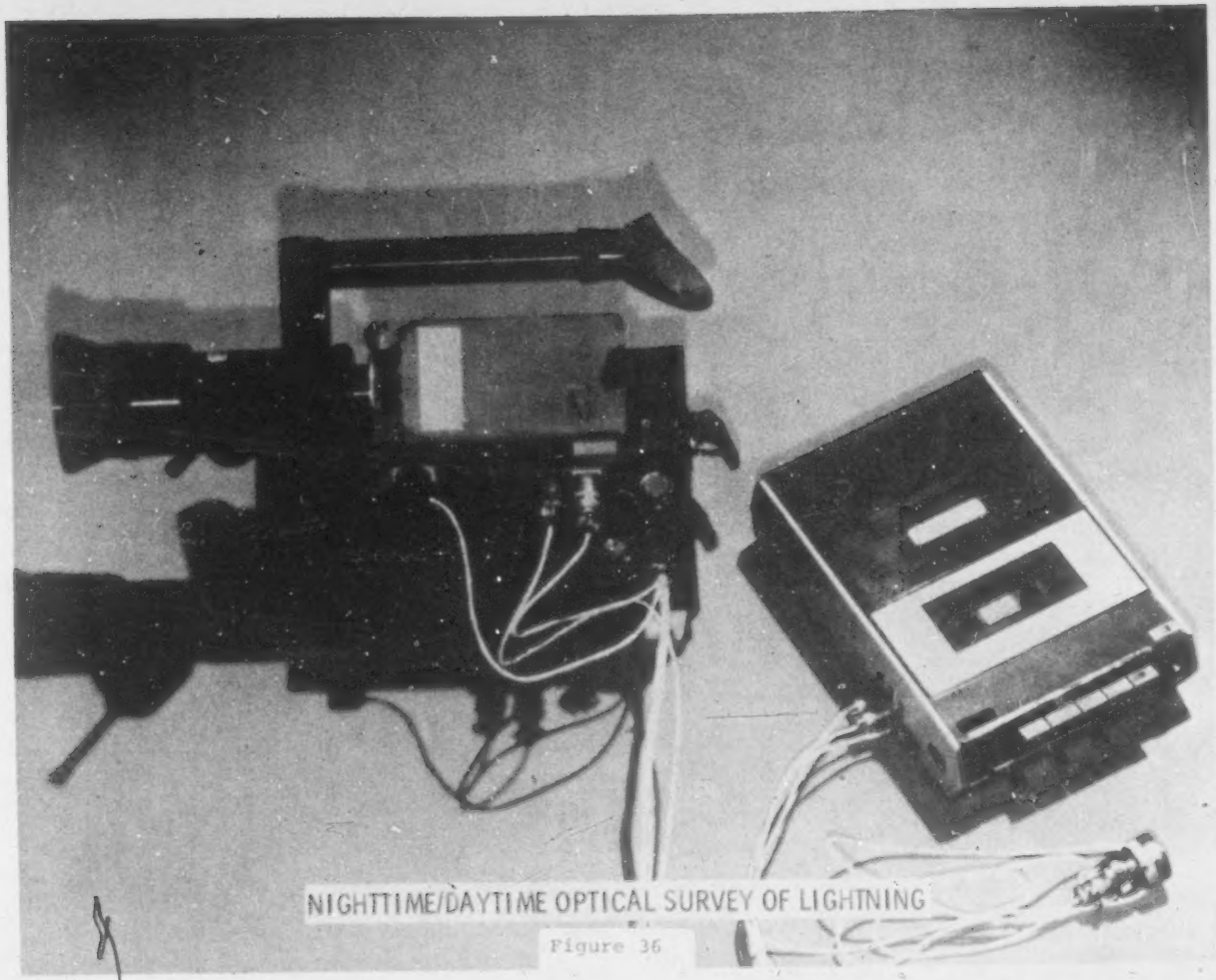
February 1982

Figure 34



INDUCED ENVIRONMENT CONTAMINATION MONITOR

Figure 35



NIGHTTIME/DAYTIME OPTICAL SURVEY OF LIGHTNING

Figure 36

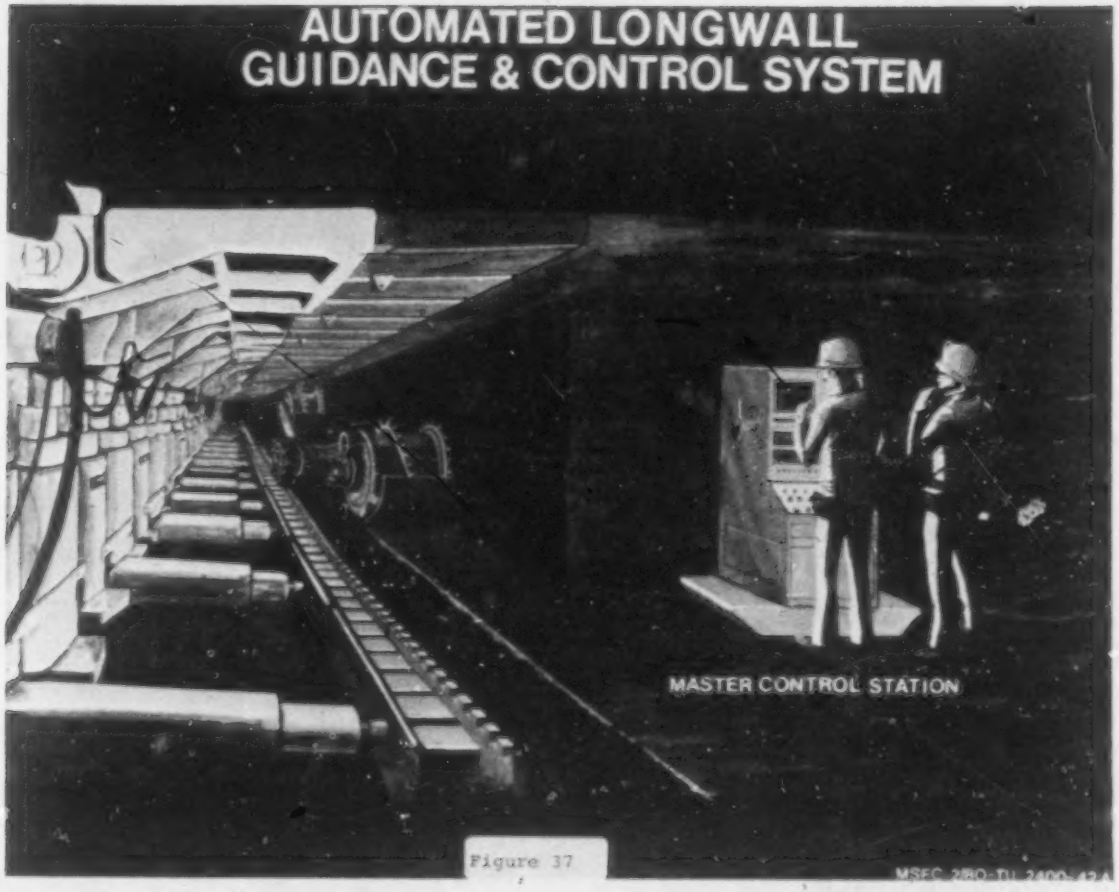

AUTOMATED LONGWALL
GUIDANCE & CONTROL SYSTEM
MASTER CONTROL STATION

Figure 37

580-82

SUPPORTING RESEARCH AND TECHNOLOGY

- MAJOR THRUST
  - CHEMICAL PROPULSION
  - LARGE SPACE STRUCTURES
  - DATA SYSTEMS
  - PHYSICAL SCIENCES
- PUBLICATIONS AND PRESENTATIONS ON ADVANCEMENTS
  - OVER 260 PUBLICATIONS AND PRESENTATIONS
  - SIXTY ARTICLES PUBLISHED IN ARCHIVE JOURNALS
- PATENTS
  - NINE PATENTS AWARDED

Figure 38

STATEMENT FOR THE RECORD
BY
DR. W. R. LUCAS
DIRECTOR, MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TO

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

OF THE

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

Mr. Chairman and distinguished members of the Committee:

Introduction

It is a pleasure to again have the opportunity to present an overview of activities at the Marshall Space Flight Center. Our accomplishments have been very substantial; we have had an extremely busy and productive year; and excellent progress has been made in support of the Space Program.

Key Personnel

Before proceeding with an overview of activities, I want to introduce others who will testify and note significant personnel changes which have occurred since our presentation last year to the Subcommittee.

On the agenda you will note that Mr. Robert E. Lindstrom, Manager of the Shuttle Projects Office; Dr. Fred Speer, Manager of the Space Telescope Project Office; and Mr. William R. Marshall, Director of the Program Development Directorate, will be making presentations. Mr. James E. Kingsbury, Director of the Science and Engineering Directorate, will conduct the tour of MSFC facilities. I would like to briefly mention at this point that Mr. Kingsbury was named a Fellow by the American Institute of Aeronautics and Astronautics during 1981. Also, Mr. Clyde Foster, Director of the MSFC Equal Opportunity Office, received the Philip A. Hart award from the Urban Environment Conference, an alliance founded by the late Senator Hart, for his significant contributions to urban and working environments in his community.

Since we have had a large number of retirements among our key personnel, I would like to mention their replacements and other personnel changes at this time. Mr. John S. Potate, who previously served as the Associate Director, has moved to industry and his responsibilities have been assumed temporarily by myself and others of my staff. The Manager of the Spacelab Payload Project Office, Mr. James A. Downey, in July replaced Mr. O. C. Jean who retired. Other principal changes included Mr. Jerry W. Richardson, Deputy Spacelab Program Manager; Mr. William C. Bradford, Director of the Data Systems Laboratory; Mr. George D. Hopson, Director of the Systems Analysis and Integration Laboratory; Dr. George F. McDonough, Director of the Systems Dynamics Laboratory; and Mr. William F. Taylor, Director of the Test Laboratory. Deputy directors of laboratories designated during 1981 included Mr. William C. Snoddy, Space Sciences; Mr. James B. Sterett, Structures and Propulsion; and Mr. Charles Cataldo, Materials and Processes. Mr. William R. Reynolds was named the Associate Director for Management in Science and Engineering. Within the Administration and Program Support Directorate, Mr. Charles L. Adams was named the Director of Facilities and Mr. Ismail Akbay, Director of Technology Utilization. Although we have lost a number of our senior personnel through retirement, their repiacements have served in key capacities throughout the Center and have become able and competent managers. The basic organization at MSFC has not changed since the last visit of the Subcommittee.

Summary of Major Accomplishments

As a Center, we share a deep sense of pride with our associate NASA Centers, NASA Headquarters, and contractors in the singular accomplishments during 1981 of two successful manned Shuttle launches. The Space Transportation System (STS) 1 launch on April 12 was the first U.S. manned space flight in nearly six years, followed by the STS-2 turnaround flight on November 12. On a much smaller scale, but still satisfying to a segment of our Center working on Materials Processing in Space was the successful launch of the Space Processing Applications Rocket (SPAR IX), which occurred on January 20, 1981.

The Marshall Space Flight Center has an impressive number of space "firsts" to its credit, beginning with development of the launch vehicle for the Free World's first manned spacecraft, and including the World's largest launch vehicles, the Free World's first Space Station, and the World's first lunar surface manned vehicle. These notable achievements all occurred nearly a decade ago. Following the successful STS-1 flight, an imposing list of firsts has been added to MSFC achievements for 1981, and I would like to recount them as follows: The STS-1 flight was the first launch of a recoverable and reusable manned spacecraft; the largest solid rockets ever flown were used, and it was the first time man has flown on solid rockets. The highest performance large rocket engine in history was first utilized, and STS-1 was the first launch of a rocket system manned on the first flight. Also, this was the first recovery of a primary propulsion system, intact and available for reuse.

Efforts at MSFC during 1981 were not confined to ropulsion systems. A portion of the payload carried on STS-2 was developed by MSFC and significant progress has been made in development of future payloads. Spacelab, the versatile modular laboratory to be carried aboard the Orbiter, was delivered to the U.S. by the European Space Agency in December and is

being prepared for its first flight aboard the Shuttle in 1983. MSFC is the NASA interface with the European Space community on Spacelab. The primary mirror for the Space Telescope was polished and coated in December and this marked an important milestone. In Materials Processing, a second joint endeavor agreement was signed in February 1982. These agreements, which consist of joint ventures without an exchange of funds, provide the initial steps in the commercialization of space by making room available on board the Space Shuttle for industry to conduct experiments in the near weightlessness of space.

We have reported previously on the highly successful High Energy Astronomy Observatory (HEAO) program, consisting of three spacecraft observatories launched in August 1977, November 1978, and September 1979, respectively. These observatories provided extraordinary data on X-rays, gamma rays, and cosmic rays in space, which are adding greatly to the nation's knowledge of astronomy. Each has completed its mission successfully, but analysis of data will continue for many months. The propellants for the third observatory, HEAO-3, were expended in May 1981, and it reentered the atmosphere in December 1981.

Location

For the benefit of new members of the Committee, operations at the Marshall Space Flight Center are conducted at three primary locations. The principal site is within the Redstone Arsenal, on 1,840 acres under a nonrevocable use permit from the U.S. Army. The Arsenal, a military installation which covers over 38,000 acres, is adjacent to Huntsville, Alabama, which has a population of over 146,000. Near the Center is the Research Industrial Park where several of the Center's contractors are located. The Alabama Space and Rocket Center (ASRC) is also located nearby. MSFC has a cooperative agreement with the Alabama Space and Rocket Center which provides for ASRC operation of the MSFC Visitor Information Center, located at ASRC, and for bus tours of MSFC, including selected stops to view space hardware. The University of Alabama in Huntsville campus, a state university maintaining high-quality scientific, engineering, and management education programs is located nearby with an enrollment of 5,000. Also located in Huntsville is another state university, Alabama A&M with an enrollment of 4,400, and the private Oakwood College with an enrollment of about 1,300. In addition to the libraries of the universities and a large public library, an extensive Scientific and Technical Library on the Arsenal is jointly operated by the Center and the U.S. Army.

The Huntsville/Madison County Jetport which serves the Huntsville/Decatur communities, and where a growing number of industrial firms are locating is within a few miles of the Center. The Redstone Army Airfield (Boeing 747 capability), to which the Center has full access, is adjacent to the Center. The Tennessee River which provides a deep water connecting route to the Michoud Assembly Facility at New Orleans, to the National Space Technology Laboratories in Mississippi, and also to the Kennedy Space Center, borders the Arsenal and the Center has direct access to docking facilities on the river.

Since the Center is located within the military reservation, it purchases from the Army certain support services, such as maintenance of the access roads and utilities.

The Michoud Assembly Facility (MAF), where the External Tank for the Space Shuttle is being manufactured, is located 15 miles east of New Orleans, and is a component installation of MSFC. The facility occupies 832 acres, and provides 3.5 million square feet of floor space, including the main assembly plant, which has an area of 43 acres under one roof. Other Federal agencies, such as the Department of Agriculture, U.S. Navy, and U.S. Army, use physical space and conduct activities at Michoud in areas not required by MSFC. This arrangement provides for best utilization of this Government facility and for a sharing of costs.

The Slidell Computer Complex (SCC), located at Slidell, Louisiana, 35 miles northeast of New Orleans, is a component installation of MSFC. The facility occupies about 14 acres, and includes over 118 thousand square feet of floor space (100 thousand is in the main computer building). The complex provides automatic data processing services in support of programs for NASA facilities, primarily MSFC, the Michoud Assembly Facility, the National Space Technology Laboratories, and NASA contractors. Other Government agencies and their contractors are permitted to use office space and computer time at SCC on a cost-sharing basis.

A number of the individual facilities at MSFC and its component installations are unique within NASA, the nation, and the rest of the free world. The combined capability of the science and engineering laboratories, special development facilities, and test facilities, provide a unique national resource for the designing, developing, and testing of complex space systems. The acquisition cost of the assets of the Marshall Space Flight Center and its installations in Louisiana, including fixed assets in progress, and contractor-held facilities at various locations as of September 1981, was $752,165,000.

Personnel

The Center had 3,561 civil service employees on board at the beginning of FY-81. In March we were informed that this number would be reduced to a permanent strength ceiling of 3,385 by September 30, 1981. As part of this reduction decision, we were required to phase out all Department of Energy and NASA-sponsored energy work at MSFC. To assist in this reduction, the Office of Personnel Managment granted early retirement authority, which resulted in the loss of 245 employees. This loss, combined with normal attrition, eliminated the necessity for an involuntary reduction in force, and enabled the Center to initiate a recruitment and placement program. As a result, the Center was able to hire over 100 technical people into the engineering disciplines, mainly the Science and Engineering laboratories, on a selective basis. In this way, the Center was able to replace a number of the skills lost through the retirement of personnel and to rebalance skills to support emerging needs.

Although the Center has been able to maintain an appropriate skill mix balance, even after the directed reduction of 176 manpower spaces, we are currently experiencing severe hiring limitations. As of October 1981, we have been required by OMB to control the civil service work force on a Full Time Equivalent (FTE) basis rather than an end-of-year head count ceiling. An FTE workyear is defined as 2,080 regular paid hours. Our full-time permanent FTE for FY-82 is 3,317 manyears, as compared to a head count ceiling of 3,385 at the end of FY-81. This change in the method of controlling the civil service ceiling impacts our ability to hire at any given point in time, and makes it quite difficult to lay out a viable college recruiting plan. Our hiring plan is based on expected attrition, but actual hires must be based on when the losses actually occur. Consequently, continuation of the current hiring limitations will impact not only our plans for hiring technical and managerial personnel, but will severely restrict our ability to achieve our Affirmative Action Plans.

Safety

Within the area of Industrial Safety, 1981 was the eighth consecutive year at the Center without a fire loss, and property damage from other causes was considerably reduced from 1980. Although the number of lost-time accidents increased over the previous year, no serious personnel injuries resulted. Efforts have been intensified and will be continued to reverse the trend in lost-time accidents and to further reduce the already small property damage losses.

Equal Opportunity Program

The most outstanding Affirmative Action Accomplishments for FY-81 were as follows:

During FY-81, the non-professional and professional promotion goals were exceeded. Of the total MSFC non-professional promotions, 16 percent went to minorities, exceeding the goal of 15 percent. Of the total MSFC professional promotions, 36.2 percent went to minorities and women, exceeding the goal of 20 percent. MSFC exceeded the Affirmative Action Plan (AAP) 10 percent goal of supervisory appointments for women and minorities. This fiscal year, six females and one minority have moved from non-professional to professional positions. During FY-81, for a period of 5 months, the Center was unable to hire from any source due to a freeze on hiring. As a result, we were unable to follow through on our commitments and when the freeze was lifted, some of the minority applicants were unavailable.

The Marshall Center continues to offer feeder programs such as Worker-Trainee, Feeder Cooperative, Professional Cooperative, and Secretarial Cooperative programs to help increase the number of qualified minorities and females for future MSFC permanent employment. Other special employment programs involving a high percentage of minorities and females include Summer Research Apprenticeship, Federal Junior Fellowship, Faculty Fellowship, Student Aid, Summer Student, and Permanent Part-Time. The overall minority and female representation in these special employment and feeder programs is approximately 65 percent.

Small and Small Disadvantaged Business Program

In FY-81, the Small Business Program at MSFC totaled $47.2 million in direct small business contract obligations. This represented a 6.8 percent program growth over FY-80 and was 113.6 percent of the Center's projected small business goal. Within the total of $47.2 million in 1981, MSFC obligated $16.1 million on small disadvantaged (minority) business contracts. These obligations on small disadvantaged business contracts increased 5.2 percent over our FY-80 accomplishment. Additionally, the Center's major prime contractors obligated $12.4 million in first-tier small disadvantaged subcontracts, resulting in an overall Small Disadvantaged Business Program total of $28.5 million.

Energy Management

The Marshall Space Flight Center has reduced total energy consumption by 49.5 percent (a cumulative savings of 1,740,000 barrels of oil) since 1973. The majority of the reductions have been achieved by stringent conservation measures. We have a number of facility modifications underway which will assure even further reductions over the next few years. Included are: solar heating and cooling systems; a utility control system; and modifications to the heating, ventilating, and air-conditioning systems in the major buildings at the Center.

Program/Project Activities

The major program/project activities approved for implementation are included in this overview, with the exception of the Projects which will be presented by Mr. Lindstrom and Dr. Speer, and are summarized in subsequent paragraphs. Mr. Marshall will present the definition and feasibility study activities which are also summarized in this statement.

Space Shuttle Activities

Space Shuttle activities were highlighted by successful launches and flights of the Space Shuttle Columbia on April 12 and November 12. The MSFC hardware elements, the Space Shuttle Main Engine, the External Tank, and the Solid Rocket Booster, achieved all flight objectives and performed to specification. These two flight tests demonstrated that the Shuttle system design is sound and that the Shuttle can fulfill its role as the country's basic Space Transportation System. While continuing to concentrate on the primary development program and flight objectives, the Center increased its efforts in production management, cost reduction, and an improvement of operational effectiveness.

Following completion of the STS-1 and STS-2 flights, the Space Shuttle Main Engine Project has shifted development and test program emphasis from the 100 percent rated power level to completion of engine certification at the full power level (FPL), or 109 percent thrust. During 18,000 seconds of development test firings, problem areas associated with operational life at the 109 percent thrust level were discovered. Modifications to solve these problems have been completed and the first of a four-cycle certification test series has been completed, approximately two months ahead of schedule. The FPL certification will be completed in the second quarter of FY-83.

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The External Tank Project is on schedule for delivery of the first lightweight tank in the last quarter of FY-82. This tank, which increases the Space Shuttle payload capability by over 6,000 pounds, will be used for the STS-6 flight in January 1983. Production continues to accelerate at the Michoud Assembly Facility, and today, six tanks are in various stages of assembly. The tooling and facility programs are on schedule to support a production rate of 24-per-year in 1987. To achieve this, improvements are being introduced concurrently to increase tooling and facility productivity. In addition, the producibility program, aimed at reducing the External Tank cost, is already providing cost benefits and is being accelerated in FY-82 and FY-83.

The successful recovery of the Solid Rocket Boosters from STS-1 and 2 demonstrated the capability of the system to be refurbished and reused in the Operational Flight Program. The majority of the hardware was recovered without damage and required only the planned refurbishment. However, some thermal and water impact loading of the aft skirt caused damage which has necessitated hardware modifications. The program to increase the performance of the booster to achieve a 2,000 pound payload gain is on schedule with test firings in FY-82 and FY-83, and delivery of those improved motors is projected for the third quarter of FY-83. The filament wound case option for the Solid Rocket Motor (SRM), has been selected for implementation planning pending Congressional reprogramming authorization. Plans are to use filament wound Solid Rocket Motor cases for several flights per year, starting in 1985. This will yield an additional payload gain of 6,000 pounds.

MSFC has completed the initial cycle of Production Readiness Reviews (PRR's) of the ET and SRB prime contractors. This review activity, supported by personnel from other NASA organizations and the Department of Defense, assessed the contractor's planning and readiness to support the 24-per-year flight rate in FY-88. Follow-up reviews of the prime contractors and PRR's of the subcontractors are scheduled later this year.

MSFC worked in conjunction with KSC, JSC, and Shuttle contractors to reduce the overpressure wave experienced at SRB ignition on the first Shuttle flight. By performing numerous hot firing tests, utilizing Marshall's 6.4 percent scaled model of the Shuttle and the launch facility, several modifications to the launch facility were identified which reduced the overpressure level observed on the second Shuttle launch to an acceptable level. Overpressure testing in support of the Vandenberg Air Force Base launch pad configuration is being conducted during FY-82.

Studies have been concluded which defined a Shuttle thrust augmentation concept to accommodate heavier payloads, particularly for missions into polar orbit from the Western Test Range. The Main Propulsion Test Article (MPTA) was utilized for several special tests this past year, including a special propellant loading test for External Tank Thermal Protection System (TPS) enhancement techniques. Planning is in progress for MPT static testing at full power level (109 percent) to verify the Main Propulsion System.

At the Kennedy Space Center's launch site, all of the elements of the Space Shuttle for which the Marshall Space Flight Center is responsible are undergoing final flight preparations for STS-3. The Huntsville Operations Support Center (HOSC) is supporting the prelaunch checkout and testing, and will provide real time support to the STS-3 launch countdown.

Inertial Upper Stage

The Inertial Upper Stage (IUS) is being developed by the USAF, Space Division under an agreement with NASA, with the Boeing Aerospace Company as the prime contractor. The primary objective of this highly reliable, expendable upper stage system, carried into orbit in the cargo bay of the Shuttle, is to deliver DOD and NASA spacecraft to high-energy orbits unattainable with the basic Space Shuttle capability. Two high-performance, solid-fuel rocket motors, an interstage structure, and an avionics equipment support section are the fundamental elements of the IUS two-stage configuration. The IUS also offers adaptability for integration with the Titan 34-D launch vehicle.

Since early November 1981, significant milestones have been successfully achieved in the IUS Full Scale Development (FSD) program. Included are the shipment to the Eastern Launch Site (ELS) of the first flight IUS vehicle (IUS-2 scheduled for a Titan launch in late 1982); completion of the vehicle component and system level qualification tests; completion of the extendable exit-cone deployment mechanism qualification tests for the second stage Solid Rocket Motor (SRM); completion of structural testing for both Titan/IUS and STS/IUS vehicle configurations; initiation of the SRM qualification test program; completion of the formal qualification tests for the Titan/IUS operational flight software; delivery of the STS/IUS Pathfinder Test Vehicle (PTV-D) to ELS for site activation; and the initiation of the vehicle acceptance tests for the first STS/IUS flight vehicle (IUS-1). To date, a positive and stable performance margin is being projected for the IUS-1/TDRS-A mission (capability - 5,027 pounds; requirement - 4,940 pounds).

In the coming year, the remainder of the IUS qualification test program (SRM's, Airborne Support Equipment, and STS/IUS operational flight software) is scheduled to be completed to support the first STS/IUS launch (IUS-1/TDRS-A), currently planned for January 1983. Planning, procurement, and production effort are also continuing in support of five additional IUS/TDRS missions.

Spacelab Program

The Spacelab, for which MSFC has the program responsibility, continues to progress well and in accordance with current Space Shuttle flight schedules. Spacelab is a major international cooperative program between NASA and the European Space Agency (ESA) that is being developed as a key element of the Space Transportation System. Designed as a versatile modular laboratory to be carried in the Shuttle Orbiter bay, it provides manned modules (with shirt-sleeve environment) and/or unpressurized instrument pallets suitable for conducting research and applications activities on Shuttle missions.

Major program progress was made in the past year with the delivery from ESA to NASA of the flight module and initial ground support equipment. This hardware provides the necessary elements for the first Spacelab flight, and is currently undergoing inspection, reassembly, test, and checkout preparatory to Spacelab 1 integration. Additionally, the MSFC-developed Orbital Flight Test (OFT) pallet system flew successfully on STS-2 last November, fully supporting all payload requirements. Production of the NASA-procured Spacelab hardware is progressing satisfactorily. This flight hardware will include 5 Spacelab pallets, a core module, an experiment segment, an igloo, a component of flight racks, an instrument pointing system, and miscellaneous hardware. Initial component deliveries, scheduled to begin later this year, will include 2 of the 5 pallets and associated hardware.

The hardware required for the pallet-only Spacelab mode (the igloo and additional pallets) and the remaining ground support equipment will be delivered prior to the end of this fiscal year. The second OFT pallet system with the OSS-1 payload will be flown on STS-3, and integration of the Spacelab hardware, software, and experiment complement for the first Spacelab flight will have begun by midyear.

Spacelab Payload Mission Management

This Center is responsible for mission management of Spacelab Missions 1, 2, and 3, as well as certain partial payloads for future Shuttle missions. Mission management includes the definition and development of instruments and equipment, payload mission integration and operations, maintenance of the interface between users and the Space Transportation System (STS), and providing the focal point for mission planning, integration, and operation within STS constraints.

We have made considerable progress in preparation for the first three Spacelab Missions and partial missions. Mission 1 accomplishments include delivery of the Spacelab hardware to ESA to start payload physical integration. Approximately 95 percent of the ESA experiments have been integrated and 80 percent of the NASA experiments are ready for the start of physical integration. Mission 1 will carry 22 European Space Agency-sponsored experiments and 14 NASA experiments. Projected Mission 1 activities are to complete delivery of NASA experiment hardware and mission equipment, and complete the physical integration at KSC.

For Mission 2, the design of the major mission peculiar equipment has been completed. During 1982, we plan to baseline the ground operations requirements, conduct the flight operations review, and initiate the experiment acceptance reviews.

Mission 3 accomplishments include a revision of the payload complement and redefinition of the mission milestones. Plans for 1982 include continuation of analytical integration leading to the integrated payload final design and operations review.

Progress on partial mission assignments during the year included continuation of analytical integration and mission planning activities, accomplishment of final design reviews, and integration readiness reviews. These activities will continue in 1982.

Materials Processing in Space

The Marshall Center is responsible within NASA for exploring and developing the potential for materials processing in space. The primary objectives of the Materials Processing in Space Program are to demonstrate the potential processes, to foster technological innovation; to isolate and characterize the gravitational effects that occur during the production of common materials on Earth and thus, identify candidates for processing in space; and to promote private sector initiative in applied research and commercialization. The results of private sector exploitation may be realized either through improved production technology on Earth or through production of some unique materials in space.

During 1981, tangible steps toward commercialization have been accomplished through the completion by McDonnell Douglas Astronautics Corporation (MDAC) of the Continuous Flow Electrophoresis System flight hardware in preparation for flight on STS-4. Increased commercial interest is evidenced by the formalization of a second Commercial Joint Endeavor with a California Electronics firm, GTI Corporation, which plans to develop a solidification furnace and to market services and samples. Also, to date, Technical Exchange Agreements have been signed with John Deere and Company (graphite management in cast iron); INCO, a Research and Development Center based in New York State (electroplating phenomena); and with the DuPont Company (catalysts).

The NASA ground-based research program has provided new data showing that Manganese-Bismuth has a high strength magnetic phase not previously identified and not predicted by theory; that fine dispersions of Aluminum-Indium can be produced in low gravity, but not on Earth where Aluminum and Indium are normally immiscible; and that a Gallia-Calcia glass can be formed in low gravity by acoustic levitation, and then gas bubbles can be removed from the molten gas specimen. Gallia-Calcia glass cannot readily be formed on Earth, but is desired because of its optical prospects.

It is expected that Continuous Flow Electrophoresis in low gravity will provide a process to separate live human Beta cells from other, undesirable pancreatic cells. There are clinical indications that pure Beta cells can be injected in diabetic patients to restore their ability to assimilate sugar and, thus, overcome a life-time of dependence on daily injections of insulin.

Flight hardware has been developed for experiments (Monodisperse Latex Reactor and Static Electrophoresis Device) to be flown on STS-3 and subsequent missions. Flight hardware for Spacelab 3 will be completed and delivered in midyear. The Materials Experiment Assembly (MEA-A) will also be completed in midyear in preparation for flight on STS-7. A second flight unit (MEA-B) is expected to be evolved from the thermal breadboard hardware. New or modified flight experiment devices will be developed subject to the availability of funding. Although the advanced furnace system, Solidification Experiments System, was terminated due to budget constraints and cost growth (the hardware is being delivered to the Government for potential future use), work is progressing in this area with industry leading the participation, as noted above.

High Energy Astronomy Observatories (HEAO)

The High Energy Astronomy Observatory program consisted of a series of three large unmanned observatories which were developed and operated under the direction of MSFC for scientific investigations in high energy stellar astronomy. Each observatory contained more than 1½ tons of very-specialized instruments for the study of X-rays, gamma rays, and cosmic rays. Knowledge obtained is helping to explain such puzzling astronomical objects as quasars, pulsars, and blackholes. These observatories were the heaviest unmanned spacecraft ever launched and were developed at the lowest cost per pound for large automated scientific spacecraft.

Significant scientific results continue to be obtained from the analysis of data from HEAO-1, which was launched in August 1977 and collected data for 17 months before being terminated in January 1979. Initially, this observatory was scheduled to operate for six months. HEAO-1 data included the first systematic all-sky scan catalog of stellar X-ray sources and the first reproducible all-sky map of surface brightness for the X-ray background. Much of the "missing mass" or unaccounted-for material of the universe was identified as dust and gas between galaxies in galactic clusters. The HEAO-2, which was launched November 1978 with a design life of one year, operated 29 months. The abundance of scientific data from HEAO-2 contains new findings about stellar formation and evolution, mechanism of stellar X-ray production, compositions and thermodynamics of supernova remnants, and contribution of unresolved sources to X-ray background. The HEAO-3, with a mission design lifetime of six months, was launched in September 1979 and actually operated for 20 months. Scientific results reveal new information on radiation from the galactic center; cosmic ray composition; and processes which generate cosmic rays. Scientific participation in these studies has been greatly expanded through an active Guest Investigator Program, in which over 400 scientists analyze HEAO data and are currently publishing findings. HEAO-1 reentered the Earth's atmosphere and was consumed in March 1979 and HEAO-3 reentered in December 1981. HEAO-2 is still in orbit but inactive.

Flight Experiments

The Center has been active in developing flight experiments for the Space Shuttle as well as other vehicles of opportunity and currently has over 30 experiments approved for flight in the next few years. Examples of this effort are described in subsequent paragraphs.

Experiments sponsored by the Office of Space Science and Applications (OSSA) are for the study of gamma ray bursts and transients aboard the Gamma Ray Observatory (GRO) spacecraft. These experiments are currently under development. Another OSSA experiment, which will be used to evaluate the potential of satellite tracking and prediction of severe storms, Nighttime-Daytime Optical Survey of Lightning (NOSL), was flown on STS-2 and is scheduled to fly again on STS-4.

The Induced Environment Contamination Monitor (IECM), sponsored by the Office of Space Transportation Systems (OSTS), is a complex of 11 instruments, designed to provide a comprehensive set of contamination and pressure environment data important to the determination of the adequacy of the Space Shuttle System (STS), to meet the requirements of a large variety of payloads. The data will also help to define the nature and location of contamination sources whether known or unexpected. The IECM has flown on STS-2 and is currently scheduled to be flown on STS-3 and STS-4 and Spacelab 1 and 2.

The Office of Aeronautics and Space Technology (OAST) sponsors the Long Duration Exposure Facility (LDEF) experiments which will determine the effects of long duration exposure to a space environment on various samples of materials and functional items of equipment. MSFC has been assigned eight experiments to be flown on LDEF in January 1984.

In addition to developing experiment hardware, the Center is making significant contributions to the analysis and use of data obtained in operation of experiments. In 1981, Center scientists and engineers were members of the investigation team for the Dynamics Explorer spacecraft and the Solar Maximum Mission, both of which were launched on expendable launch vehicles. Significant among the preliminary findings is the observation by the MSFC-developed instrument on the Dynamics Explorer A spacecraft of a Polar Wind, a rapid moving gas that flows out of the Earth's atmosphere. This important new piece of information will be of significance in helping to understand the origin of ionized gases in near Earth space and the influence on communication and spacecraft charging. A second "first" was made by the MSFC instrument on the Solar Maximum Mission where the magnetic field in the transition region above sun spots was photographed for the first time. This information is of significance in helping to understand the dynamics of the sun's atmosphere and thus further elucidate the Earth-sun interaction.

Space Telescope

Development of the Space Telescope continues toward readiness for launch as a Space Shuttle payload in 1985. The Space Telescope is a 2.4-meter optical telescope designed for use during the remainder of this century. Considerable progress was made during 1981 in the fabrication of the major elements of the Optical Telescope Assembly (OTA). The primary mirror's final polishing and coating were completed, and analysis of test samples indicates that the reflectance measurements actually exceed specifications. The fabrication of the graphite epoxy focal plane structure, as well as the OTA titanium main ring, was completed in 1981. During the year, most design reviews and interface definitions were completed as scheduled. The European Space Agency (ESA) supplied Faint Object Camera and Solar Array have progressed in fabrication satisfactorily during 1981, and remain on schedule for delivery to the U.S. in 1983. Contract awards for major elements of the operations ground system were accomplished during 1981, including the Science Operations Ground System to TRW in December, and the Operations Control Center software support to Computer Sciences Corporation (CSC) in November. The Mission Operations contract negotiations with Lockheed Missiles and Space Company (LMSC) were completed in

December, and the contract will be awarded in the first quarter of 1982. The Science Institute contract was awarded to the Association of Universities for Research in Astronomy, and the first Institute Director, Dr. Riccardo Giacconi, was selected during 1981. Plans for 1982 include completion of the Support Systems Module and Space Telescope Critical Design Reviews, initiation of final integration of the OTA and assembly of the Scientific Instruments, and fabrication of a number of subsystems for the Support Systems Module.

Minerals Extraction

The Automated Longwall Program, begun in 1975 under an Interagency Agreement between NASA and DOE, has been completed. The major objective of the program was to develop a system to control the cutting drums of a coal mining machine (a longwall shearer) automatically. Marshall Space Flight Center was assigned the task because of the extensive Center experience in the guidance and control of spacecraft, and in systems engineering.

At the end of this program, MSFC had accomplished several firsts: completely automated a double-drum longwall shearer at an aboveground facility (for the first time in the U.S.); successfully used a coal depth sensor on underground mining machinery to assist the mining machine operators in leaving a specified amount of roof coal (for the first time in the U.S.); installed all sensors and control equipment on an operating longwall shearer; and designed, fabricated, and tested a low-cost display/processor for use in controlling coal mining machinery. This processor also makes available, for the first time, a rugged, portable recording/analyzing system for underground measurements and control.

Programs Assigned for Definition

Concurrent with the management of ongoing programs, the Center continues to look toward the future. A small component of our organization, Program Development, performs advance studies, makes feasibility determinations, provides preliminary design and program definition, and supports NASA in continually assessing the need for future initiatives in the Space Program. A number of promising objectives for the future are under study. The following information presents the status of current planning efforts, and describes several possible uses and courses of action for these projects. However, please note that none of these programs have been yet approved for development. Further, the possible schedules and capabilities discussed reflect one set of a wide range of possible options being developed for future consideration and do not necessarily reflect the current views of either NASA or the Administration.

Space Platform

The Space Platform (SP), formerly known as the Power System Platform, will be a free-flying spacecraft which will support scientific and application payloads by providing electrical power, heat rejection, attitude control, and communications and data management capabilities. Periodic visits by the Space Shuttle will be made in order to exchange payloads and for maintenance. The Space Platform will also have the capability to provide service to the Orbiter in order to extend the duration of Spacelab sortie missions. The Space Platform will provide the nucleus for future growth to larger, unmanned platforms and permanent manned low-Earth orbit capabilities.

Initially, this project had been designated the 25 kW Power Module, and was assigned to this Center for definition in 1979. This project is viewed as the first step in an evolutionary program leading to manned space platforms. Plans are to continue Phase B-type studies on this project through May 1, 1982. The Center planning is timed to support a new project start in FY-84.

Shuttle-Derived Vehicles

Several "Shuttle-Derived Vehicle" concepts are currently being investigated. These studies show that the basic propulsive elements of the Shuttle can be adapted in a variety of ways to meet the nation's space transportation needs as they develop. Unmanned launch vehicles using the Shuttle solid rocket boosters can be provided with all the benefits of commonality with Space Shuttle elements. Unmanned vehicles using External Tank and SSME's, along with SRB's, could provide a capability to launch larger/heavier payloads that are beyond the weight/volume capability of the basic Shuttle, when that need develops. In addition, some concepts under study could enhance the basic Shuttle/Orbiter vehicle. Reusable liquid rocket boosters are being examined as potential replacements for solid rockets, with attendant benefits in payload capability and operating costs. Although the exact nature and timing of future transportation needs cannot yet be foreseen, these planning studies and companion technology efforts are being undertaken to assure that this nation can meet future launch requirements.

Gravity Probe-B

Definition and preliminary design study of the Gravity Probe-B (GP-B) project is proceeding. This definition study is planned to conclude in late FY-83 to support commitment to development in FY-84. The GP-B will test one of the most fundamental concepts in physics--Einstein's Theory of Gravitation, the General Theory of Relativity. This theory provides the framework for our current understanding of the large scale structures of the universe. It also forms the basis for our speculation and limited knowledge about astrophysical objects such as blackholes, pulsars, and quasars. Because of the extreme difficulty of accomplishing experiments that test the unique predictions of general relativity, it is the least tested of all fundamental theories of physics. GP-B will provide a definitive test of this theory.

Advanced X-Ray Astrophysics Facility (AXAF)

Another program of high priority at MSFC is the Advanced X-Ray Astrophysics Facility (AXAF). This program is nearing completion of the conceptual phase and is expected to enter the definition phase later this year. AXAF will offer substantial improvements in the quality of X-ray data over that obtained by HEAO-2, which was a highly successful mission. To demonstrate how this goal can be attained, a technology program is underway at two major suppliers of space optics to produce X-ray mirrors which, although scaled down in size, will be fully representative of the smoothness and accuracy required by the AXAF telescope.

AXAF is planned for launch by the Shuttle toward the end of this decade, and will be maintained over a 15-year period by periodic visits. This revisit capability will permit on orbit maintenance and permit new, more advanced instrumentation to be placed in the focal plane as it becomes available.

Tethered Satellite System

We have completed definition and are entering an advanced development stage of an early space flight demonstration project which will use the Space Shuttle as a base. This project, the Tethered Satellite, is a captive instrumented craft which will be reeled out on a long tether from the Shuttle bay into low altitudes not attainable on a extended basis with free-flying satellites. Deployment to altitudes above the Shuttle can also be accomplished, and is expected to yield important results in the field of plasma physics. The first experimental flight, now planned for 1987, will demonstrate proof-of-concept and technology. During the operational phase to follow, scientific and applications missions will be accomplished on a regular basis with this reusable facility. Plans are being formulated around a potential U.S./Italian program for the development and subsequent use of the Tethered Satellite System.

Manned Space Platform

The availability of the Space Platform in the late-1980's in combination with the Shuttle/Spacelab systems and subsystems will enable a transition from the Spacelab sortie mode of manned operations to a free-flying Manned Space Platform (MSP) in low-Earth orbit.

The MSP concept uses the Space Platform, a combined habitability/experiment module which is derived from Spacelab and crew equipment developed for the Shuttle. Basic resources such as power, heat rejection, communications, attitude control and station keeping are provided by the Space Platform. The MSP would begin operations in 1990 and would be used for support of science missions and commercial materials processing activities which require continuous manned support in space.

Another important role for the MSP is its use as a test-bed for future space operational capabilities.

Extensive development and demonstrations in space will be required before implementation in an operational facility will be feasible. Candidate operations to be demonstrated on the MSP will include deployment/assembly/construction of large antennas/solar arrays/optics, spacecraft servicing, and propellent refueling of orbit transfer vehicles.

Plans for achieving this permanent United States manned presence in space embody an evolutionary approach, which begins with a development start on the cornerstone system, the Space Platform in FY-84, and on the manned habitation system in FY-86.

Research and Technology Activities

The Science and Engineering laboratories of the Center provide extensive technical support to the MSFC programs and projects. A typical example of applied technology in support of programs was in the design and test of modifications to the Shuttle launch pad to overcome the overpressure pulse experienced on the first Shuttle launch. In addition to such support and assuring technical adequacy of contractor designed and developed hardware, complementary programs have been initiated dealing with productivity enhancement, new cost-efficient materials development, and process automation techniques.

Significant progress was made in the Center's research and technology program. Over 260 publications and presentations were made on the results of programs designed to advance the state of both science and engineering. Of this total, over 60 were articles published in archive journals. One example of the progress made is the completion of a 7½-year test on a set of flight batteries that were operated in a flight system configuration under environments simulating a spacecraft in low-Earth orbit. The circuitry in the system included a battery protection refurbishment circuit, designed by MSFC personnel and patented for NASA, which resulted in the end-of-life rating of the batteries being essentially the same as the original nameplate rating.

Summary

The past year has been one of exceptional results, with major progress accomplished toward the overall goals and objectives of the NASA Space Program. The Center has continued in its role as a major contributor to these objectives. As Shuttle flights become operational, we will move ahead with development and flight of the payloads and experiments to fulfill the goals of providing a national return and pay-off for this initial investment in space. We will also energetically pursue additional joint endeavors with industry for viable commercial materials processing experiments in space. In parallel, we will continue to investigate possible low-cost unmanned launch vehicle concepts to complement the Space Shuttle by the end of this decade, and to work on possible new propulsion vehicles for use beyond Earth orbit. Also, we will continue our planning efforts for the possible development of the Space Platform.

The Center will continue to conserve its resources, to institute improved management methods, and to operate as efficiently as possible. At the same time, we will continue with the traditional dedication to technical excellence which has been the hallmark of this Center since its beginning in 1960.

TRANSCRIPT OF TESTIMONY

by

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MANAGER, SHUTTLE PROJECTS OFFICE

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

of the

COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

February 12, 1982

MR. LINDSTROM: Mr. Chairman, I am pleased to discuss with you today the Shuttle projects for which the Marshall Center is responsible. I have submitted a prepared statement for the record and would now like to summarize the content of the statement for you. Figure 1 lists the basic areas of responsibility and I would like to introduce to you the people who manage these areas: Mr. Jim Odom for the External Tank Project, Mr. George Hardy for the Solid Rocket Booster Project, Mr. J. R. Thompson for the Space Shuttle Main Engine Project, and Mr. Jim Sisson in the Systems area. I will be discussing each of these areas, but I would first like to take a moment and reiterate the role of the Center within the Shuttle Program. I have categorized that role into two phases (Figure 2) - the development phase and the operations phase.

In the development phase, we are responsible for the development and certification of three major elements: the External Tank, Solid Rocket Booster, and the Main Engines. We have been responsible and will continue to be responsible for the propulsion system testing at the National Space Technological Laboratories (NSTL) in Mississippi. We also participate with the Johnson Space Center (JSC) in propulsion and ascent flight system integration as we look at the total vehicle system. As you will note in my prepared statement, we are conducting a significant amount of effort in performance improvements to our elements which add to the payload capability of the Space Shuttle.

In the operations area, our major role is in production and logistics support of these three major elements. We provide launch support for the Kennedy Space Center (KSC) and for Vandenberg Air Force Base as well as being heavily involved in supporting the Vandenberg activation. Operational improvements are now high on the list in terms of producibility of our hardware. A review of the requirements of the hardware will result, hopefully, in a reduction of these requirements, thereby reducing unit cost, realizing other cost reductions, and simplifying the launch processing of the vehicle.

In conjunction with each project, I will follow this general outline (Figure 3). I will briefly summarize the project from its inception to today, what are the future plans, discuss the accomplishments during the last year, and major activities forecasted for 1982. I then will take just a moment to discuss the key project emphases we will be working during the next few years.

The External Tank is being produced by the Martin Marietta Company at the Michoud Assembly Facility. You will hear a more detailed report at Michoud tomorrow from Martin. Mr. Odom and I will be with you there for that report. I show here the key elements (Figure 4), the launch of STS-1, the first operational flight in November with STS-5, and the first Vandenberg flight in October of 1985. Our design and development program started in 1973 with a contract let to the Martin Company. We built four ground test articles in the 1976 and 1977 time frame. We will complete the design, development, test and evaluation (DDT&E) phase for the first four flight tanks at the end of this year. We have two versions of the tank, the basic design, better known as the heavyweight tank, and the lightweight tank, in which we have reduced the weight by some 6,000 pounds. We expect to complete qualification of the lightweight tank in FY-82.

The rate tooling and rate facilities program started in the 1978 and 1979 time frame. These facilities and basic tooling will enable us to achieve a rate capability of 24 per year in FY87. We have, in place, a very extensive producibility and production readiness program. This program is aimed at achieving the rate capability as well as reducing the unit cost. The readiness activity will be completed in 1984, but our producibility program will continue as long as we are achieving cost effective results. We are nearing completion of the first two operational flight articles for STS-5 and STS-6. The first lightweight tank will be launched in January 1983. It is currently on schedule and will be on dock at Kennedy in September 1982. As depicted, our production buildup increases from seven to twelve and finally 22 in 1987.

The External Tank development program is nearing completion (Figure 5). We have had success with both the STS-1 and STS-2 launches. As you are aware, we had an insulation debond problem on STS-1; however, we resolved it for STS-2 and believe we have resolved it for all subsequent flights. The tank fully meets the flight requirements for an operational vehicle. We are on schedule for the launch of STS-3. I wanted to show you a picture of the tank for STS-3, before you see it on TV, when it rolls out on Tuesday morning (Figure 6). You will notice it is unpainted, and the reason is because we saved about 600 pounds and about $15,000. It doesn't look quite as good as STS-2, but we believe it will do the job.

DR. LUCAS: I expect to get at least $15,000 worth of flack.

CHAIRMAN FLIPPO: Sure is an ugly looking thing.

MR. LINDSTROM: We did not show that picture to Bill for a long time.

CHAIRMAN FLIPPO: You mean we are not going to see a sparkling white Shuttle External Tank out there? Are you going to do the same thing with the SRB's? You're not going to paint them?

DR. LUCAS: No, they have to be painted for corrosion protection. You can't get away from that on the Solid Rocket Boosters SRB's. They land in salt water and that's a tough environment.

CHAIRMAN FLIPPO: Well, I guess white will go with this color about as well as anything.

MR. LINDSTROM: Our fourth tank has been installed in the Vehicle Assembly Building (VAB) at the Kennedy Space Center and is on schedule for STS-4 (Figure 5). As I indicated, the lightweight tank program will provide a payload increase of about 6,000 pounds. The lightweight tank program is on schedule. We have completed the critical design review and modified all the structural tooling with some improvements being made to the tooling to increase its productivity. We have completed the structural testing at Marshall (Figure 7). We modified the initial structural test articles to simulate the lightweight tank and conducted the testing here in our facility. We have completed the structural assembly, and as I have indicated, we are on schedule for the STS-6 flight (Figure 5).

In the operations area, we initiated in the Solid Rocket Booster and External Tank projects a formal Production Readiness Review, much as the Department of Defense (DOD) does in their production program (Figure 8). We conducted these reviews last summer. Participants were not only from MSFC but the Department of Defense as well. The reviews have provided very successful results. We intend to continue these reviews on a delta basis.

When we are at Michoud tomorrow, you will see six tanks in assembly. We have the components under contract to be delivered to Martin through ET-22. Our activation of the new Thermal Protection System (TPS) cells is nearing completion.

As indicated, we have increased our effort on producibility, and you will see some of this tomorrow when you are Michoud. I think you will be very impressed. The tooling to support a 24 per year rate is on schedule. As we have moved in the rate tooling and introduced the lightweight tank tooling mods, we have been able to automate certain improvements. We have completed the plans to rearrange the manufacturing flow in that facility. When Martin first came into the facility....

CHAIRMAN FLIPPO: May I ask you....You mentioned that the components are under contract through ET-22. In other words, it is not manufactured. When you get into the 24 per year rate, do you plan to fabricate the components at Michoud or will they still be contracting the components?

MR. LINDSTROM: Components will still be under contract with various vendors throughout the country. We plan for Michoud to be principally an assembly facility: the major structural assembly, TPS and final assembly. The Martin Company is only under contract for components through tank 22. That is the number that is required based on the lead time. We are considering a larger block buy of tanks on an incentive basis with the Martin Company. They would then be able to go to their vendors and purchase a larger number of components and hopefully get a much better price.

CHAIRMAN FLIPPO: Thank you.

MR. LINDSTROM: We have completed plans to rearrange the manufacturing flow at Michoud. We will discuss this further tomorrow. This is also being submitted through the FY-83 C of F project.

CHAIRMAN FUQUA: How much money is in the budget?

MR. LINDSTROM: I believe $2.7 million, Mr. Chairman.

CHAIRMAN FUQUA: We were concerned late last year, or maybe the early part of this year, I don't remember exactly, but that is immaterial, that there might be considerable modifications at Michoud in order to achieve that point or rate.

MR. LINDSTROM: No, sir. We have these facility projects in...the modifications principally are the through aisle development.

CHAIRMAN FUQUA: You have got to change your whole flow through there?

MR. LINDSTROM: Well, we are changing parts of the flow. Basically, we have to open some doors - build some forty-five foot doors - but essentially we want one big aisle to reduce our choke points. The major part of the cost is the movement of an x-ray facility. This has been reviewed by our people, Martin people,and also by Sverdrup and Parcel. We believe we have come to the best option in terms of cost to achieve this result.

CHAIRMAN FLIPPO: Well, if I might pursue that, I think I misunderstood what you are saying. Are you not planning a capital expenditure of several million dollars...in excess of $15 million for this facility?

MR. LINDSTROM: Our C of F program in FY-83 for Michoud is about $20 million.

CHAIRMAN FLIPPO: I thought that is what the Chairman was referring to...is that correct?

MR. LINDSTROM: Two million is for maintenance and rehabilitation of the basic support facility, power system, and air conditioning. About $18 million is for the facility to achieve the production rate of 24 per year. Mr. Chairman asked about modifications of the facility. Some part of that is for new construction and I will discuss that. I believe about $2.7 million is for the through aisle. We have about 4 million in there for some cranes for the VAB and there is $7 million in there, I think, Jim, for Cells K and L.

MR. ODOM: $6.7 million.

MR. LINDSTROM: $6.7 million for Cells K and L, which are TPS facilities.

CHAIRMAN FUQUA: We have six cells now, haven't we for TPS?

MR. ODOM: We have nine cells of various types that we are using. Cells K and L are the two new ones we are bringing on line in 1983. We also have an additional Super Light Ablator (SLA) cell that will be coming on line in 1983 and 1984. So we will end up with 12 cells to achieve the 24 per year rate.

MR. LINDSTROM: We will be performing a requirements review to reduce our TPS requirements for the operational flights based upon our development flight experience. We may well get a considerable higher production performance from these cells than 24. We are very hopeful of going back and reviewing the actual thermal requirement and the ice prevention requirements for the tank and reducing them which would reduce the flow time through these cells.

CHAIRMAN FUQUA: Is the Michoud facility going to be adequate to do this? There was some concern they may not even have enough room in there.

MR. LINDSTROM: No, sir. We do not have that concern. We believe there is adequate room in the facility. The plan lays out the facility for 60 tanks, and we are evaluating to determine which would be the optimum plan for 24. Martin Company studies have indicated there is sufficient room. Our own internal studies have and, as I have indicated, Sverdrup and Parcel also evaluated a facilities program for the next ten years in terms of what the requirements are. At the present time, we are estimating only the costs for the 24 per year. We are hopeful of achieving a higher rate for the same investment, but only time will tell.

CHAIRMAN FUQUA: You have got to buy more equipment, jigs and all this other...

MR. LINDSTROM: Yes, sir.

CHAIRMAN FUQUA: Other associated equipment.

MR. LINDSTROM: Yes, sir.

MR. LINDSTROM: We have around $37 million for rate tooling. Our budget will be about $50 million in FY-83.

CHAIRMAN FUQUA: How much?

MR. LINDSTROM: $37 million for rate tooling which includes some for the lightweight tank and around $50 million in FY-83 with the principal amount to attain the 24 per year rate capability. The total of the tooling, I believe our figure, Jim, for 24 per year is around $168 million.

MR. ODOM: That's right, total.

MR. LINDSTROM: The majority of that is for the TPS tooling. I believe some $117 million. Of course, this is a requirement that has developed late in the program. Our tooling and the assembly in the structural area I believe is around $35-40 million. Included in our tooling estimate is also the transportation equipment to transport the necessary tanks completed at Michoud then shipped to the launch site. It also provides handling equipment for the "in plant" moves.

CHAIRMAN FUQUA: More barges?

MR. LINDSTROM: I don't believe we plan any more barges at this time, do we Jim?

MR. ODOM: To attain the 24 per year rate we will have to add two single unit barges. We think we can get by now with the additional two, certainly if the rate caps at 24. We will not need the large four unit barge we had previously looked at in the last two or three years.

MR. LINDSTROM: I do have a backup chart with these figures on them if you would like to see them, Mr. Chairman.

CHAIRMAN FUQUA: I would.

MR. LINDSTROM: This is our production spares and equipment account on the External Tank (Figure 8a). I have the MAF tooling and other equipment for a 24 per year rate and our estimate of what it would take to go to the 60 per year rate assuming we have the same TPS requirements as at the present time. Currently, our tooling is $168 million. $149 million is in the class of MAF tooling: $22 million in structural, $10 million in assembly and $117 million in TPS. In addition, we spent $17 million in handling and transportation equipment and $2.2 million at vendors that are not financially capable of providing tooling and equipment for the production. Our estimates for 60 per year totals $240 million. Again, 138 of this is MAF tooling with the majority in the TPS area. We have an estimate of $39 million for handling and transportation equipment which is used at Michoud, KSC and Vandenberg, and have a potential of $60.8 million for vendor tooling. What we are saying is that we are not certain that our vendors, the small subcontractors, will be able to finance the tooling and equipment to build up their production rate. So we are showing an estimate of capital we may have to provide to smaller firms. It is hopeful that we can make a large buy. It will encourage them to perhaps make their own investment. So these are our current estimates. We believe, that based on our studies to date, that the 60 per year rate can be accomplished out of Michoud although we are also hopeful or reducing TPS.

CHAIRMAN FLIPPO: What is the transporation mode to Vandenberg?

MR. LINDSTROM: We will go by barge, as we do to Kennedy, down through the Panama Canal. Jim, where do we offload?

MR. ODOM: Right there at South Vandenberg. They are currently enlarging this existing dock facility.

MR. LINDSTROM: Do you have any further questions?

CHAIRMAN FLIPPO: Have you looked at any plans for any potential cost savings of constructing these facilities closer to Kennedy or to Vandenberg to eliminate transportation costs?

MR. LINDSTROM: A study has been completed by the Ingersoll Company for a potential west coast site for External Tank assembly. We did this for two reasons: first, the economics; secondly, some concern about security in terms of the Panama Canal shipment to the west coast. There are a number of sites which could very easily support the structural assembly.

CHAIRMAN FUQUA: Are you talking about having two sites?

MR. LINDSTROM: We are discussing the potential of a west coast site. We are just studying it and are not considering it at the present time.

CHAIRMAN FLIPPO: Are any of these figures in anticipation of two facilities?

MR. LINDSTROM: No, sir. This is only in anticipation of one facility.

CHAIRMAN FLIPPO: Then do your studies extend so far as to estimate the cost of two facilities?

MR. LINDSTROM: We have those costs and I would like to provide those for the record. We just received a study from the Ingersoll Company and have not had an opportunity to analyze it ourselves.

CHAIRMAN FUQUA: Seems like you would increase your costs, as most of the flights will be from the east coast.

MR. LINDSTROM: Our initial assessment is that we would not recommend that based on that study. It is not our intent to recommend it. Jim Odom has just received the study and I have just gone over it with him.

CHAIRMAN FLIPPO: But of course, it would be important to evaluate it.

MR. LINDSTROM: We will evaluate it not only from the standpoint of cost but the security aspect as well. If Vandenberg missions go to a very high number in the 90's or so, one might want to consider it.

CHAIRMAN FLIPPO: Well, it might be something good for the military to build out there.

MR. LINDSTROM: Figure 9 is Cell N which is our hydrogen tank SLA spray. We use the ground vibration test article as a pathfinder to verify the installation and tooling. This system has worked out quite well. In 82 (Figure 10), we will complete the STS-3 and STS-4 flights, complete the lightweight tank qualification and plan a formal requirements review with a goal to reduce requirements and tank costs.

In the operations area, once we have a buildup in our production, we plan to increase or continue our effort in producibility and production readiness. We expect to negotiate a block buy of tanks on a cost plus incentive fee (CPIF) basis. We expect to negotiate an agreement with the Martin Company where they will provide funding for a TPS component facility in order to reduce the C of F. They have taken an option on some land across from Michoud. I believe Jim had a phone call the other day advising that their Board of Directors had approved that.

Our emphasis in the External Tank is in two areas: to attain production rate capability and reduce cost (Figure 11). Our unit cost has stabilized very well in the last few years.

CHAIRMAN FLIPPO: Do you have a backup chart for all External Tank budget aspects for 83? In other words, do you have a backup chart that would include 83 numbers for tooling, for C of F and procurement.

MR. LINDSTROM: I do not have that. I can provide that to you tomorrow morning and will be happy to do that as we continue with you at Michoud.

CHAIRMAN FLIPPO: Thank you.

MR. LINDSTROM: Moving into the Solid Rocket Booster (Figure 12). As you know the Solid Rocket Booster is managed somewhat differently than the External Tank and SSME. The design and development work is done in house and Mr. Kingsbury is essentially our prime contractor. He is supported by Thiokol for the Solid Rocket Motor, and United Space Boosters Incorporated (USBI), the booster assembly contractor. This program started in 1973 (Figure 13). I will review a few key points. We had our first SRM firing in 1977 and completed qualification of the motor in early 1980. I want to make the point that our refurbishment development program, in terms of reuse and refurbishment of the Solid Rocket Boosters, will continue into 1983. We basically plan to conduct this program as part of the flight program and as such it will continue.

We have initiated some performance improvements both in a lightweight case and a high performance motor. The high performance motor Preliminary Design Review (PDR) was completed last year. We will be conducting a development firing and a test firing of this motor in the late summer of 1982 with qualification to be completed in early 1983. This motor is planned to fly on STS-8 which is in July of 1983. We have initiated some studies on thrust augmentation and a decision has been made on the filament wound case. We are in some pre-procurement activities and if we gain congressional reprogramming approval, we will initiate that activity in May with a goal to deliver the case for the first launch from Vandenberg in October of 1985. Our first motor case reuse will be on STS-6 although we have used some components from ground test motors on earlier flights. Our operational buildup follows much the same timing as the External Tank.

Again, as in the tank, we had a very successful launch and recovery of STS-1 and STS-2 boosters (Figure 14). We believe that the flight experience to date has demonstrated a high degree of design maturity on the booster as well as the reuse capability. We conducted a very thorough reuse assessment on the STS-1 hardware here at Huntsville and also at the contractors facilities. We discovered that certain reentry thermal and water entry loads exceeded our predictions and some design modifications which are in process to fix this. It will, for a period of time, until we can introduce these modifications, increase our refurbishment time and cost.

CHAIRMAN FLIPPO: You have completed the SRM filament wound case feasibility studies. Could you elaborate a little bit on that?

MR. LINDSTROM: About a year ago, we held a competition for a feasibility study for the use of a filament wound case to replace the steel case on the Solid Rocket Booster for a limited number of flights with high payload requirements. We awarded two contracts: one to Hercules and one to Thiokol Corporation. They conducted an engineering evaluation and did some test demonstrations. Based on the results of their studies as well as those performed by Marshall, we have concluded the filament wound case is a feasible approach to replace the steel segments of the Solid Rocket Booster for these flights.

CHAIRMAN FLIPPO: Is the purpose of this to get greater payloads?

MR. LINDSTROM: Yes, the purpose is to increase the payload capability.

CHAIRMAN FLIPPO: Has the payload capability exceeded what you had initially intended? Is it a new requirement placed on you by a different time date or some new requirement?

MR. LINDSTROM: It is a new requirement on the Solid Rocket Booster. I believe from the vehicle standpoint it is necessary in order to achieve some of the polar orbit missions from Vandenberg.

CHAIRMAN FLIPPO: Is it a new requirement from a time standpoint?

MR. LINDSTROM: Yes, sir. From the time we started this feasibility effort or these studies last spring.

CHAIRMAN FLIPPO: Is this an accelerated capability?

MR. LINDSTROM: Yes, sir. We anticipated that the first requirement would be in 1987 and as I have indicated, right now we are moving toward the requirement in 1985. So it is about two years earlier than we had anticipated. We believe we need to move on it.

DR. LUCAS: Of course, you know we are not going to move until we get authorization from Congress.

CHAIRMAN FLIPPO: Thank you, Bob.

MR. LINDSTROM: We have experienced a minor problem with reentry and water impact damage on the aft skirts on both STS-1 and 2. However, we are quite proud of the overall program. By plan, limited preflight testing for reuse was accomplished since we did not put a great deal of effort in proving the capability because the development flight phase of the program was to be used for this purpose. It has been a highly successful program. We recovered four boosters and most of that hardware is reusable. Again, we are very happy with this program.

We are on schedule for STS-3 and STS-4 and have initiated some performance enhancement options.

I would like to show you a few pictures of the Solid Rocket Booster recovery. Figure 15 shows the booster in the water and the frustrum on the recovery ship. The frustrum is in excellent condition for refurbishment and we believe it can be readily reused. This is the motor still in the water. The forward skirt and the motor casings are in good condition. The only difficulty we had was with the aft skirt.

Figure 16 is a view of the motor in the Kennedy wash facility prior to disassembly and shipment to Wasatch Division of Thiokol. We had two problems during the reentry. The nozzle is off as you can see. During reentry the thermal curtain failed and we experienced some damage principally to the Thrust Vector Control (TVC) system which is an Auxiliary Power Unit (APU) type TVC system. We are examining several changes, one of course, is the redesign of the thermal curtain. We are also looking downstream to simplify the TVC system which would reduce the total cost. Figure 17 shows some structural damage which occurred to the aft skirt on water impact.

In the operations area (Figure 18), we conducted Production Readiness Reviews at Thiokol and USBI. We also, together with the Kennedy Center, USBI, and our contractors conducted a very thorough lessons learned of the STS-1 processing. We initiated some 180 different actions - some very significant and some rather minor - to improve the processing of the boosters. Our initial production contracts are in negotiation.

In 82 (Figure 19), we will complete this redesign and support the STS-3 and STS-4 flights. We will conduct the first firings of the improved high performance motor. This motor will provide 3,000 pounds of additional payload over that from STS-1. Therefore, the total increase we will be attaining among the filament wound case, the high performance motor, and the lightweight case will be 9,000 pounds.

CHAIRMAN FLIPPO: Will you conduct that test at NSTL?

MR. LINDSTROM: This is a Solid Rocket Motor test which is conducted by Thiokol at Brigham City, Utah.

CHAIRMAN FLIPPO: Thank you.

MR. LINDSTROM: In the operations area, our hardware builds will continue for STS-5 and 6 with motor casting starting on STS-8. We will conduct our delta Production Readiness Reviews. Again, as with the Martin Company, we plan a block buy with a CPIF contract for the motors with Thiokol. We also have proposals from both Thiokol and USBI to invest capital to provide production facilities. We have these under evaluation at the present time.

Figure 20 is an example of a filament wound case. This is the MX cannister. The size is about 8 feet in diameter and about 20 feet long. A similar type of technology will be used for the SRM filament wound case.

Key emphases in 82 and 83 (Figure 21) will continue with the development and certification of the recovery and reuse programs. Also, vehicle performance enhancement, and as in the case of the tank, attainment of production readiness capability and cost reduction.

I will cover the Main Engine in much the same format (Figure 22). In 1975 (Figure 23), we had our first engine test. In 1975, we completed period A. In 1976, we built three engines; completed the Critical Design Review (CDR) and, contracted period B, which is the development and production phase. We built seven engines in 1980 and completed certification of the first cycle of the Columbia engines in 1979 with the second cycle occurring in 1980. We are now in process of certification at the full power level (FPL) or 109% thrust level. In period C, which is production, we have 15 engines under contract and will be buying 4 additional engines plus flight support and overhaul. We anticipate a program starting in 1983 that will provide the basis for increasing the life or use of the engine up to 55 flights and also some potential uprating of the engine.

As Bill mentioned, the performance of the engine was excellent on the first flight (Figure 24). We had no flight problems and I think the maintenance capability that was designed into the engine has been thoroughly demonstrated. We are readily able to maintain it and with its performance, the engine is a good reusable piece of hardware.

We continue to demonstrate the engine reliability - we have 138,000 total seconds firing time. Figure 25 depicts the thrust levels achieved to comprise the 138,000 total seconds. We have 93,000 seconds of firing time at the rated power level (RPL) or 100% thrust level or greater, 60,000 at RPL. We now have 18,000 plus seconds at the FPL, or 109% level, and a number of seconds at the 111% thrust level. We have initiated our full power level development on all three test stands (Figure 24). We did encounter some significant problems; however, we have put fixes in for all these problems. Our experience to date indicates we have fixed these issues, although testing has been limited.

Our certification program is proceeding with engines 2010 and 2012 (Figure 26). We have completed the first series on 2010 this week. Figure 27 represents a summary of the certification program listing the certification objectives, certification cycle requirements, and the status of the two engines. We plan to have two cycles on each engine. Each cycle requires 13 tests and 13 starts to rated power level. A minimum of 5,000 seconds total duration and 3,000 seconds at FPL, or 109% level. We do an overstress test, running for 380 seconds at the 111% thrust with different mission durations. Our first cycle has just been completed (Figure 26). We had projected completion in May so we are proceeding quite well. However, some improvements are needed in the oxidizer turbopump bearings and rotor stability. We will probably have to make some retrofits, but our engine build schedules are being maintained.

SSME FY-82 activities (Figure 28), will support the STS-3 and STS-4 flights; and, complete first series of FPL certification on engines 2010 and 2012. We will deliver the first flight set of engines for Orbiter Vehicle (OV) 099 in the summer. This set of engines will be used for the Main Propulsion Test Article (MPTA) and will be used for 109% system level testing in July and August. We will continue to demonstrate the program inspection and turnaround requirements. In addition, we expect to complete eight engine assemblies.

CHAIRMAN FLIPPO: Do you feel there is adequate funding in the 83 budget to meet all the delivery schedules for the engines for the Shuttle?

MR. LINDSTROM: Yes sir. Based on our initial discussion with the Office of Space Transportation System (OSTS) as well as their initial guidelines to us, there is sufficient funding in the 83 budget.

DR. LUCAS: Excuse me, Bob. When is the Main Propulsion Test (MPT) scheduled?

MR. LINDSTROM: It is scheduled for August.

DR. LUCAS: August of this year?

MR. LINDSTROM: August of this year. Then those engines will be taken from MPT and will be installed into the next Orbiter (OV-099) at the Kennedy Center which will be flown in January.

Our key project emphases (Figure 29) are to complete full power level certification and demonstrate the engine life capability in terms of engine uses for our spares and maintenance requirements. Our spare projections are determined by our failure rate or replacement rate and provide the basis for the operational flight program support.

I will conclude now with the Shuttle Systems area (Figure 30). We successfully supported the STS-1 and STS-2 launches both in support to our projects and support to the system. The Huntsville Operations Support Center (HOSC) supported prelaunch activities at Kennedy. We also spent a good deal of effort with Johnson and KSC developing and working the prelaunch and launch requirements. As you are aware, we had an overpressure problem on STS-1 which was resolved for STS-2. The Center made a major contribution in this area combining a considerable amount of analytical effort and testing to successfully reduce the overpressure peak by a factor of about four. Figure 31 is a picture of the 6.4% model test facility which is located in our test area. This model consists of the Kennedy launch facility and the Shuttle propulsion system.

CHAIRMAN FLIPPO: Will these support facilities be needed when you consider the Shuttle operational? Or will some support facilities...You're supporting these flights from Kennedy now. When you pronounce the Shuttle as operational will some support facilities have to continue to be provided?

MR. LINDSTROM: Yes sir, we believe so. We will continue to support early operational flights from Kennedy because there will be changes to the vehicle. We are still evaluating the procedures in terms of trying to reduce the operational turnaround. We will still be working with the engineering people for some time. We believe we will support these operational flights. In addition, as we now see NASA's responsibility from a vehicle standpoint we would expect to be supporting the earlier flights from Vandenberg until that launch team matures.

CHAIRMAN FLIPPO: I was just thinking that when they had this problem, your Center did make a contribution - a major contribution to solving it. If you had not had this support capability and if it were not provided in the operational phase could a problem of this nature be solved? I was just curious, about that.

MR. LINDSTROM: I was primarily talking in my previous answer about this facility. We will be using this facility in FY 82 to look at the Vandenberg launch facility in much the same manner. I believe we put this facility in, Jim didn't we, in 1975.

MR. KINGSBURY: That particular set up, yes.

MR. LINDSTROM: And we expected it, at that time, to be required for only about a year. But we have continued to use it both from the standpoint of reducing acoustic energy on the payload as well as the overpressure. This facility, we believe, will be required in the operations phase.

DR. LUCAS: Mr. Chairman, if I might add, this is a very flexible facility. This is the kind of facility that one needs to keep available between major flights to accomodate a Supporting Research and Technology (SR&T) program. It turns out that not only do we do this kind of testing here, but there is also a small rocket nozzle facility where we can do some advanced propulsion testing. And if facilities such as this can be supported, then instrumentation with everything that you need is there, and it is a simple matter to put in whatever configuration you would want to test. So probably, after this Shuttle testing is over - and we expected to close this facility down much earlier - we would moth ball the cell there, but could still use, hopefully, if we get it supported by SR&T, the instrumentation, the blockhouse and other fixtures.

CHAIRMAN FLIPPO: Thank you.

MR. LINDSTROM: Our support to Vandenberg has picked up (Figure 30). We review all their facility designs and also procure some common support equipment for Vandenberg. This common support equipment amounts to approximately $30 million of which we are able to place a significant amount with small businesses and disadvantaged businesses.

In 82 (Figure 32), we will continue with our main propulsion system and ascent flight system engineering effort with JSC and again, our effort in support of Vandenberg will increase. As I mentioned, we will be doing overpressure and acoustic testing associated with the Vandenberg launch test configuration at our 6.4% test facility. In the Main Propulsion Test area, we plan two special LOX loading tests to verify some configuration simplification and the static firing to verify propulsion system testing at 109% power level which will be conducted in August.

Mr. Chairman, in summary (Figure 33), we believe our progress has been excellent. We believe we have demonstrated the technical performance and we will have the production capability that will support Space Shuttle operations program. We believe we have programs in place to improve the operational effectiveness both from the standpoint of payload capability, cost reduction and simplified launch site operation. This concludes any statement.

CHAIRMAN FLIPPO: Thank you very much.

[Figures 1-33 of Dr. Lindstrom's oral presentation follow:]

AGENDA

- MSFC SPACE SHUTTLE ROLE
- EXTERNAL TANK
- SOLID ROCKET BOOSTER
- SPACE SHUTTLE MAIN ENGINE
- SHUTTLE SYSTEMS

FIGURE 1

MSFC SPACE SHUTTLE ROLE

- DDT&E
  - DEVELOPMENT AND CERTIFICATION
    - EXTERNAL TANK
    - SOLID ROCKET BOOSTER
    - SPACE SHUTTLE MAIN ENGINE
  - PROPULSION SYSTEM TESTING
  - PROPULSION AND ASCENT FLIGHT SYSTEM INTEGRATION
  - PERFORMANCE IMPROVEMENTS
- OPERATIONS
  - PRODUCTION AND LOGISTICS SUPPORT OF MAJOR ELEMENTS – ET, SRB, & SSME
  - LAUNCH SUPPORT FOR KSC AND VAFB
  - VAFB ACTIVATION
  - OPERATIONAL IMPROVEMENTS
    - PRODUCIBILITY
    - REQUIREMENTS REDUCTION
    - COST REDUCTION
    - LAUNCH PROCESSING SIMPLIFICATION

FIGURE 2

EXTERNAL TANK PROJECT

- PROJECT SUMMARY
- ACCOMPLISHMENTS
- FY 82 ACTIVITIES
- KEY PROJECT EMPHASES

FIGURE 3

EXTERNAL TANK
PROJECT SUMMARY

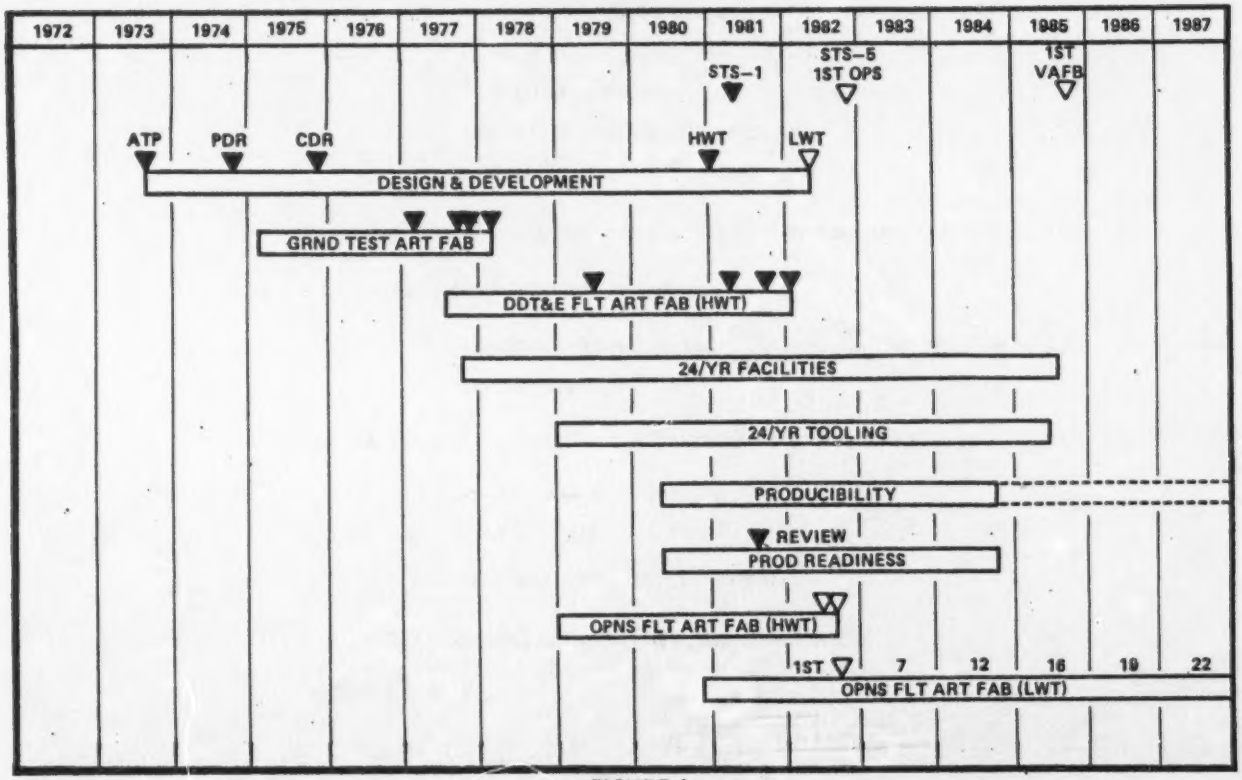


FIGURE 4

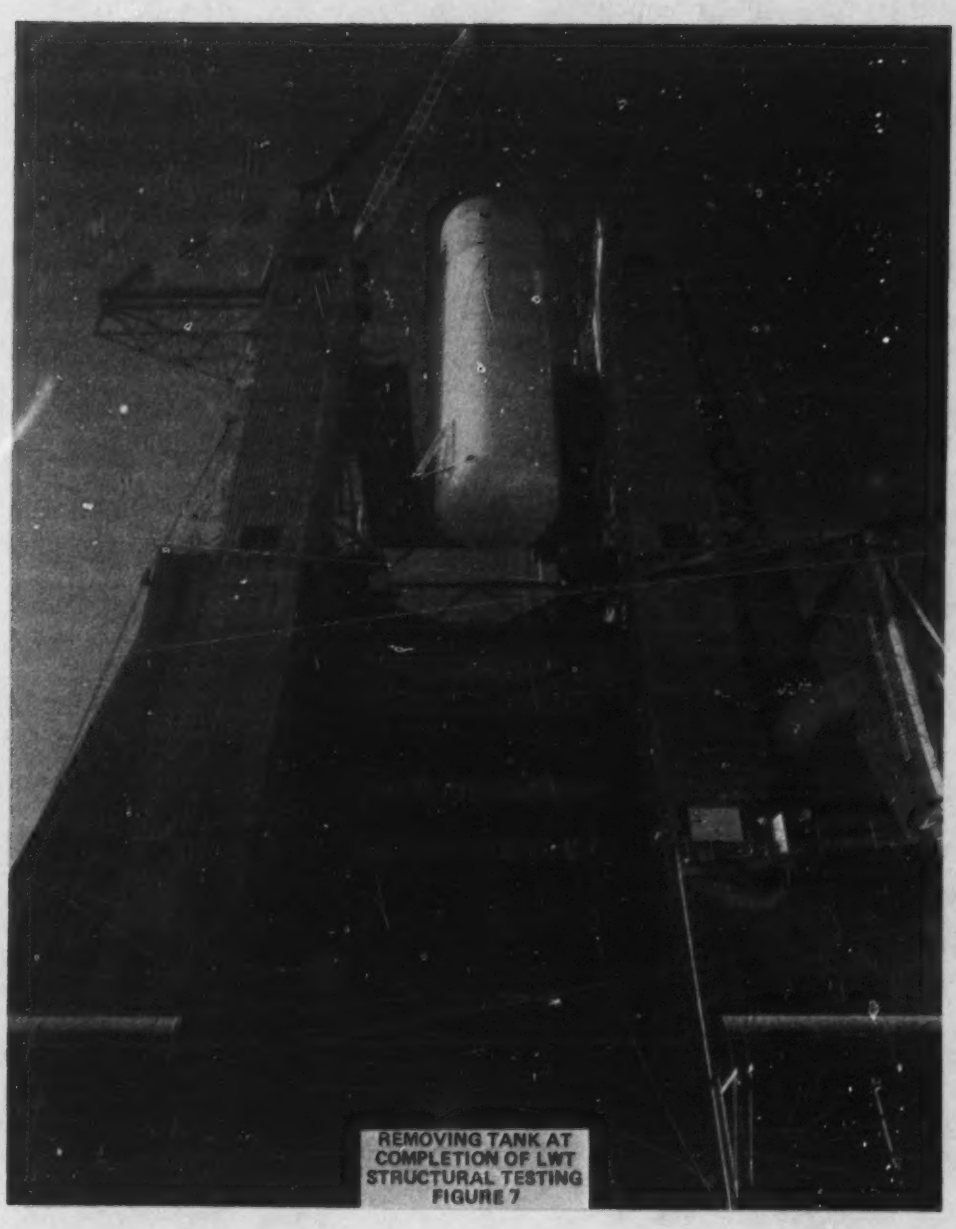
EXTERNAL TANK

ACCOMPLISHMENTS

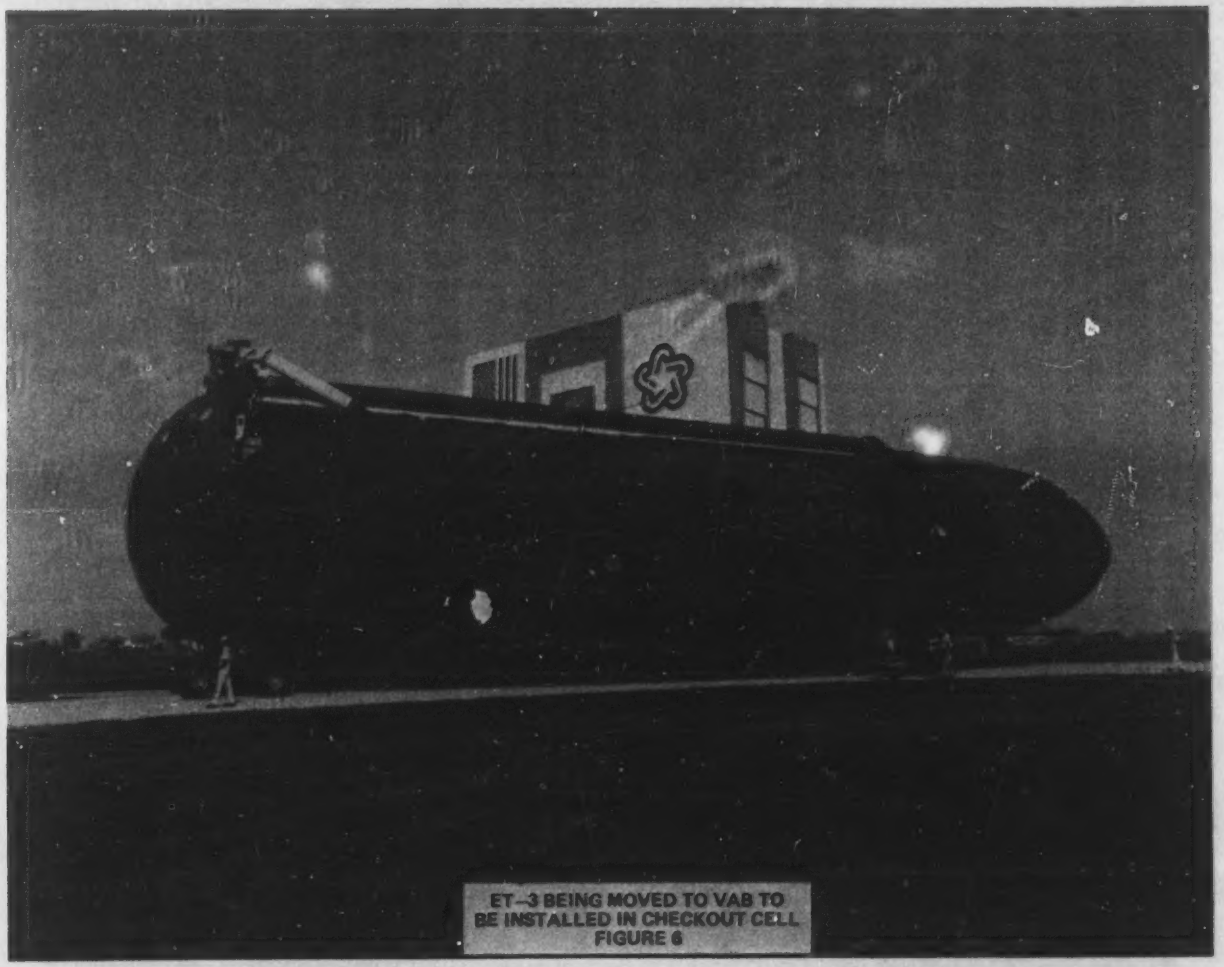
- DDT&E
  - DEVELOPMENT PROGRAM NEARING COMPLETION

    SUCCESSFUL STS–1 AND STS–2 LAUNCH
    - TPS DEBOND
    - FULLY MEETS REQUIREMENTS
  - ET–3 PRE–LAUNCH OPERATIONS ON SCHEDULE FOR STS–3
    - NOT PAINTED
    - REDUCES WEIGHT (600 POUNDS/TANK) AND COST (APPROX. $12K – $15K/TANK)
  - ET–4 INSTALLED IN THE VAB FOR STS–4
  - LIGHTWEIGHT TANK – PROVIDES PAYLOAD INCREASE > 6000 POUNDS
    - COMPLETED CRITICAL DESIGN REVIEW
    - MODIFIED STRUCTURAL TOOLING
    - COMPLETED STRUCTURAL TESTING AT MSFC
    - COMPLETED STRUCTURAL ASSEMBLY
    - ON SCHEDULE FOR STS–6 FLIGHT – DELIVERY SEPTEMBER, 1982

FIGURE 5



REMOVING TANK AT
COMPLETION OF LWT
STRUCTURAL TESTING
FIGURE 7



ET–3 BEING MOVED TO VAB TO
BE INSTALLED IN CHECKOUT CELL
FIGURE 6

EXTERNAL TANK

ACCOMPLISHMENTS (CONT'D)

- **OPERATIONS**
  - PRODUCTION READINESS REVIEW CONDUCTED
  - SIX TANKS IN ASSEMBLY AT MAF
  - COMPONENTS UNDER CONTRACT THROUGH ET–22
  - ACTIVATION OF NEW TPS CELLS COMPLETED
- INCREASED EFFORT ON PRODUCIBILITY IMPROVEMENTS AND PRODUCTION READINESS
- TOOLING TO SUPPORT 24 PER YEAR RATE ON SCHEDULE – AUTOMATED IMPROVEMENTS BEING INTRODUCED
- COMPLETED PLANS TO REARRANGE MANUFACTURING FLOW FOR 24 PER YEAR PRODUCTION RATE – FY–83 C OF F PROJECT

FIGURE 8

PRODUCTION SPARES AND EQUIPMENT

	24/YEAR	60/YEAR	
MAF TOOLING			
STRUCTURAL	22.1	46.0	
ASSEMBLY	10.1	18.6	
TPS	117.3	73.6	
SUB–TOTAL	149.5	138.2	
OTHER EQUIPMENT			
HANDLING/TRANSPORTATION	17.1	39.2	
VENDOR – TOOLING AND EQUIPMENT	2.2	60.8	(POTENTIAL)
POP 81–2 SUBMIT	168.8	240.2	

FIGURE 8A

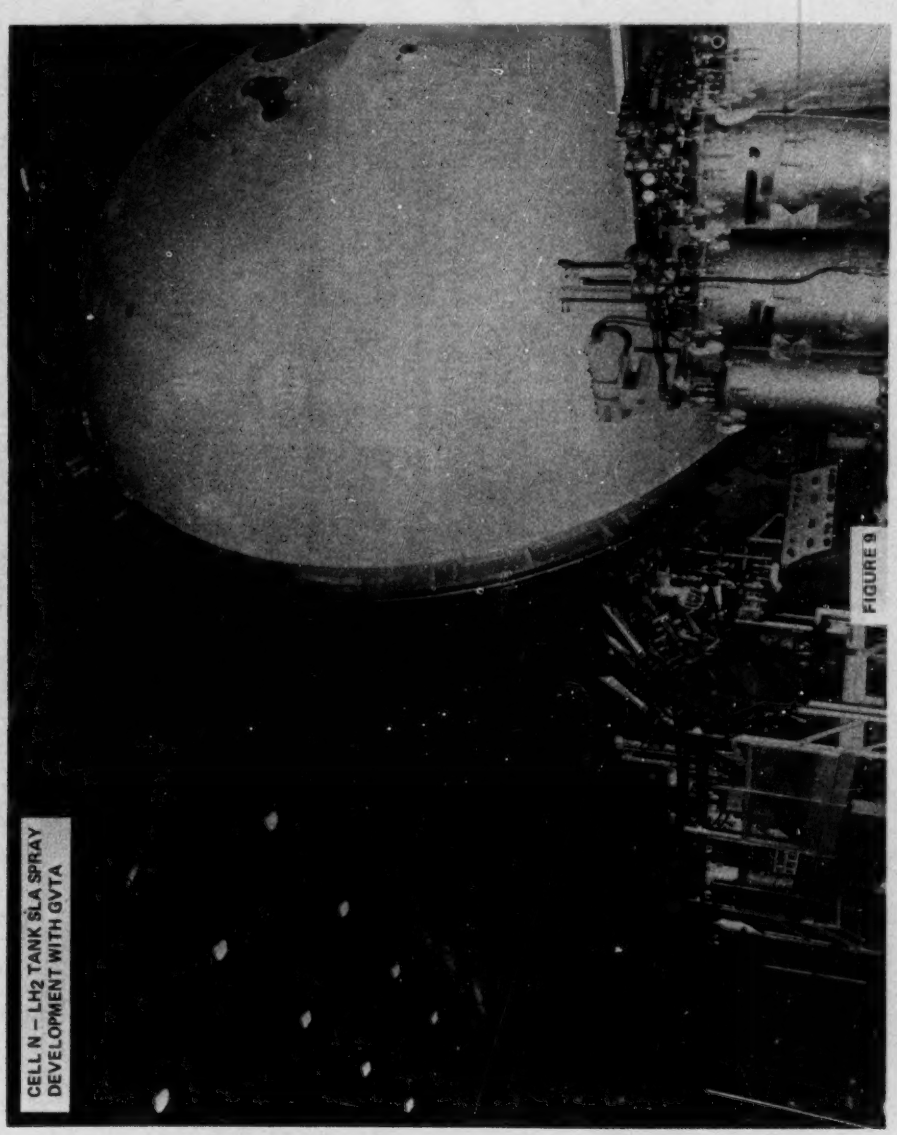


FIGURE 9

EXTERNAL TANK

FY-82 ACTIVITIES

- **DDT&E**
  - STS–3 AND STS–4 FLIGHTS
  - COMPLETE LIGHTWEIGHT TANK QUALIFICATION TEST PROGRAM
  - REQUIREMENTS REVIEW – REDUCE COST
- **OPERATIONS**
  - COMPLETE ASSEMBLY AND DELIVER THREE EXTERNAL TANKS TO KSC
    - ET–5 AND ET–6 – LAST HEAVYWEIGHT TANKS
    - ET–8 – FIRST LIGHTWEIGHT TANK
  - INITIATE ASSEMBLY OPERATIONS AT MAF ON TANKS THROUGH ET–15
  - CONDUCT DELTA PRODUCTION READINESS REVIEW
  - CONTINUE PRODUCIBILITY/PRODUCTION READINESS ACTIVITIES TO ASSURE PRODUCTION CAPABILITY AND TO REDUCE UNIT COST
  - NEGOTIATE A BLOCK BUY OF TANKS ON A CPIF BASIS
  - NEGOTIATE AN AGREEMENT WITH MMC TO PROVIDE COMPANY FUNDING FOR A TPS COMPONENT FACILITY

FIGURE 10

EXTERNAL TANK
KEY PROJECT EMPHASES

- ATTAINMENT OF PRODUCTION RATE CAPABILITY
  - TOOLING
  - FACILITIES
  - PRODUCIBILITY
  - PRODUCTION READINESS
  - SUBCONTRACTORS
- COST REDUCTION
  - REQUIREMENTS
  - PRODUCIBILITY
  - INCENTIVE CONTRACTING

FIGURE 11

SOLID ROCKET BOOSTER PROJECT

- PROJECT SUMMARY
- ACCOMPLISHMENTS
- FY 82 ACTIVITIES
- KEY PROJECT EMPHASES

FIGURE 12

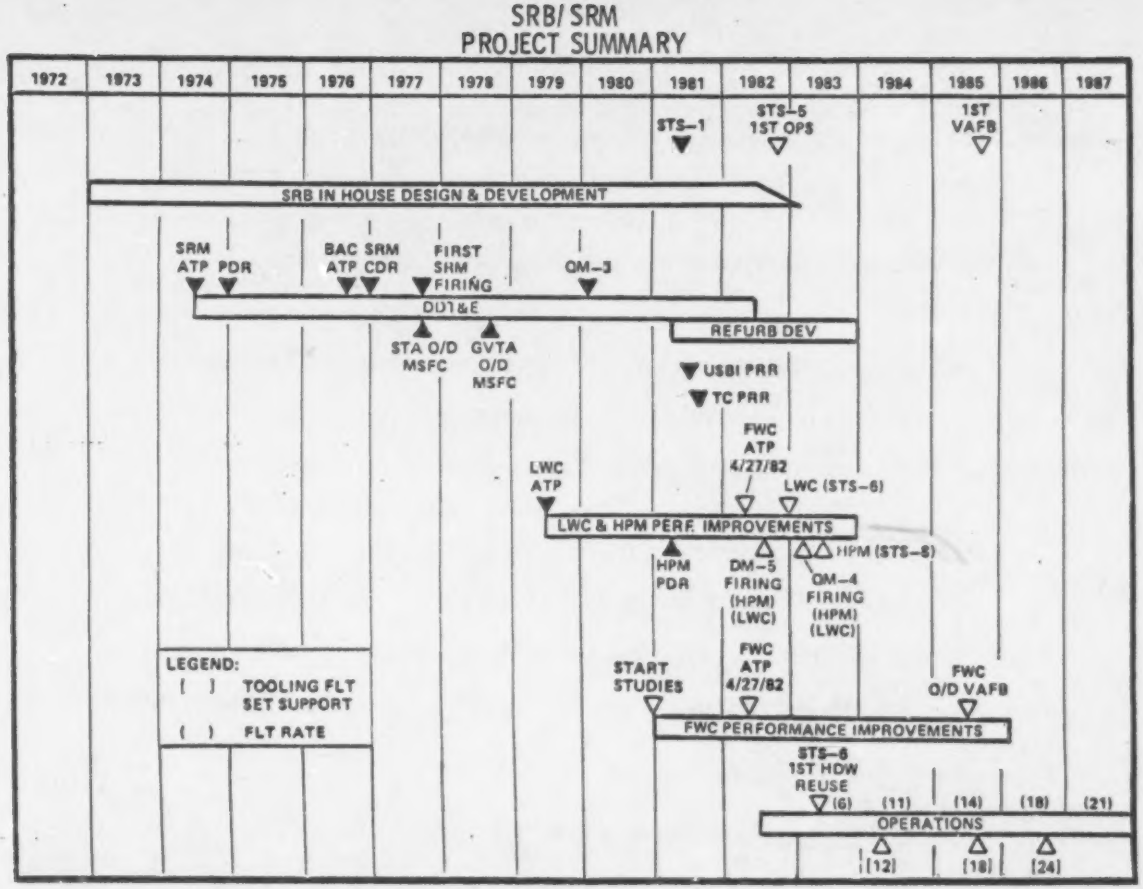

SRB/ SRM
PROJECT SUMMARY
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
STS–1
STS–5
1ST OPS
1ST
VAFB
SRB IN HOUSE DESIGN & DEVELOPMENT
SRM
ATP
PDR
BAC SRM
ATP CDR
FIRST
SHM
FIRING
QM–3
DDT&E
REFURB DEV
STA O/D
MSFC
GVTA
O/D
MSFC
USBI PRR
TC PRR
FWC
ATP
4/27/82
LWC
ATP
LWC (STS–6)
LWC & HPM PERF. IMPROVEMENTS
HPM (STS–8)
HPM
PDR
DM–5
FIRING
(HPM)
(LWC)
QM–4
FIRING
(HPM)
(LWC)
LEGEND:
[ ] TOOLING FLT
SET SUPPORT
( ) FLT RATE
START
STUDIES
FWC
ATP
4/27/82
FWC
O/D VAFB
FWC PERFORMANCE IMPROVEMENTS
STS–8
1ST HDW
REUSE
(6)
(11)
(14)
(18)
(21)
OPERATIONS
(12)
(18)
(24)

FIGURE 13

SOLID ROCKET BOOSTER
ACCOMPLISHMENTS

- **DDT&E**
  - SUCCESSFUL LAUNCH AND RECOVERY OF STS–1 AND STS–2 BOOSTERS
  - FLIGHT EXPERIENCE HAS DEMONSTRATED DESIGN MATURITY AND REUSE CAPABILITY
  - COMPLETED REUSE ASSESSMENT ON STS–1 RECOVERED HARDWARE
    - RE–ENTRY THERMAL AND WATER ENTRY LOADS EXCEEDED PREDICTIONS
    - DESIGN MODIFICATIONS IN PROCESS
    - WILL INCREASE REFURBISHMENT TIME AND COST UNTIL IMPROVEMENTS ARE COMPLETE
  - STS–3 PRE–LAUNCH OPERATIONS SUPPORT ON SCHEDULE
  - STS–4 HARDWARE MANUFACTURING AND ASSEMBLY OPERATIONS ON SCHEDULE
  - INITIATED PERFORMANCE ENHANCEMENT ACTIONS
    - COMPLETED SRM HIGH PERFORMANCE MOTOR PRELIMINARY DESIGN REVIEW
    - COMPLETED SRM FILAMENT WOUND CASE FEASIBILITY STUDIES
      - PRE–PROCUREMENT STEPS IN PROCESS
      - TO BE IMPLEMENTED AFTER CONGRESSIONAL REPROGRAMMING APPROVAL

FIGURE 14

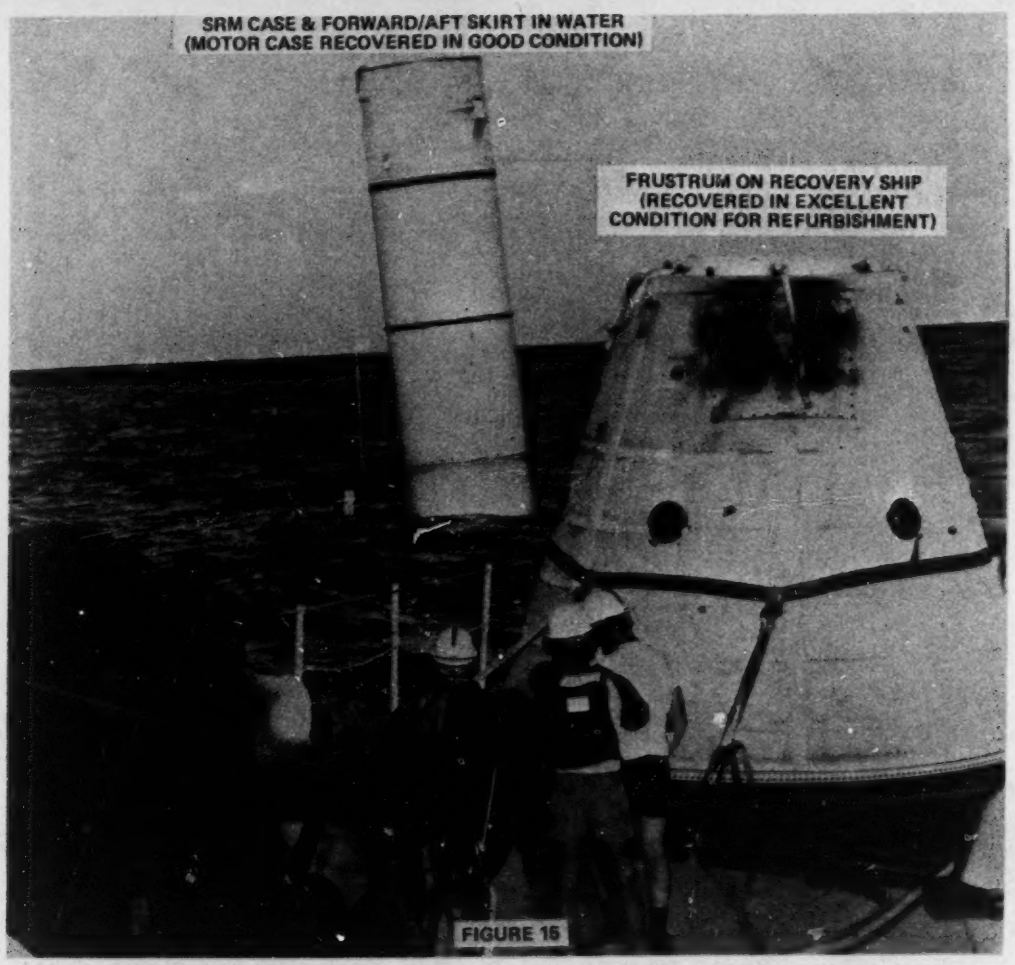

SRM CASE & FORWARD/AFT SKIRT IN WATER
(MOTOR CASE RECOVERED IN GOOD CONDITION)
FRUSTRUM ON RECOVERY SHIP
(RECOVERED IN EXCELLENT
CONDITION FOR REFURBISHMENT)

FIGURE 15

SRM MOTOR IN WATER WASH FACILITY PRIOR
TO DISASSEMBLY AND REFURBISHMENT

FIGURE 16

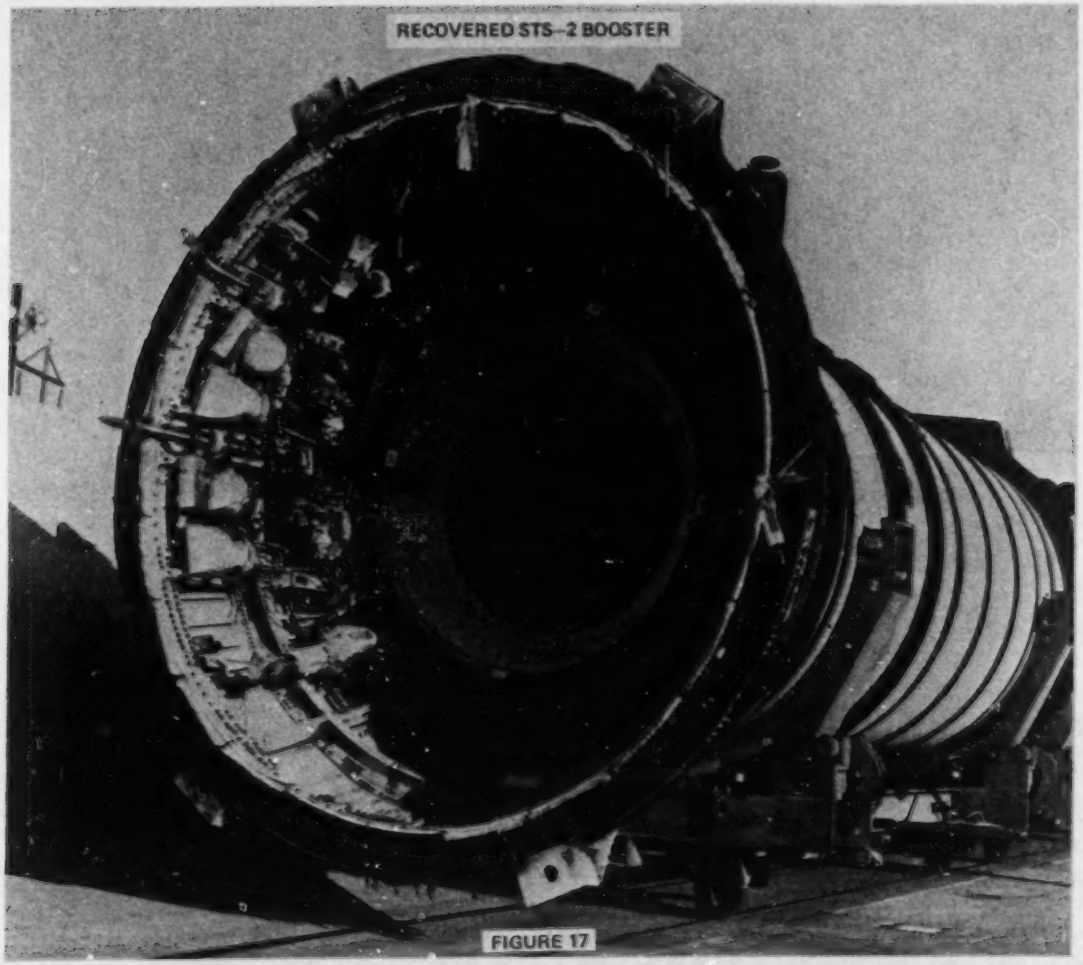


FIGURE 17

SOLID ROCKET BOOSTER
ACCOMPLISHMENTS (CONT'D)

- **OPERATIONS**
  - PRODUCTION READINESS REVIEWS CONDUCTED AT THIOKOL AND USBI
  - A LESSONS LEARNED REVIEW WAS CONDUCTED – STEPS TO IMPROVE PRODUCIBILITY AND TO REDUCE HARDWARE TURNAROUND TIME ARE IN PROCESS
  - INITIAL PRODUCTION CONTRACTS IN NEGOTIATION

FIGURE 18

SOLID ROCKET BOOSTER
FY-82 ACTIVITIES

- **DDT&E**
  - COMPLETE REDESIGN TO MINIMIZE DAMAGE TO AFT BOOSTER RESULTING FROM RE–ENTRY AND WATER IMPACT
  - STS–3 AND STS–4 FLIGHTS
  - CONDUCT THE SRM HIGH PERFORMANCE MOTOR GROUND TEST AND BEGIN MOTOR CASE PREPARATION FOR THE QUALIFICATION MOTOR TEST
  - INITIATE DEVELOPMENT OF THE SRM FILAMENT WOUND CASE

- **OPERATIONS**
  - INITIATE STS–5 AND STS–6 HARDWARE ASSEMBLY OPERATIONS AND INITIATE MOTOR PROCESSING FOR STS–8
  - CONDUCT PRIME CONTRACTOR (THIOKOL/USBI) DELTA PRODUCTION READINESS REVIEWS
  - INITIATE PROCUREMENT FOR A BLOCK BUY OF SOLID ROCKET MOTORS – CPIF
  - COMPLETE EVALUATION OF THIOKOL PROPOSAL FOR COMPANY FUNDING OF PRODUCTION FACILITIES – UP TO 24 PER YEAR
  - COMPLETE EVALUATION OF USBI PROPOSAL FOR COMPANY FUNDING OF PRODUCTION FACILITIES – UP TO 24 PER YEAR

FIGURE 19

AN EXAMPLE OF FWC MANUFACTURING TECHNIQUE
(MX CANNISTER)

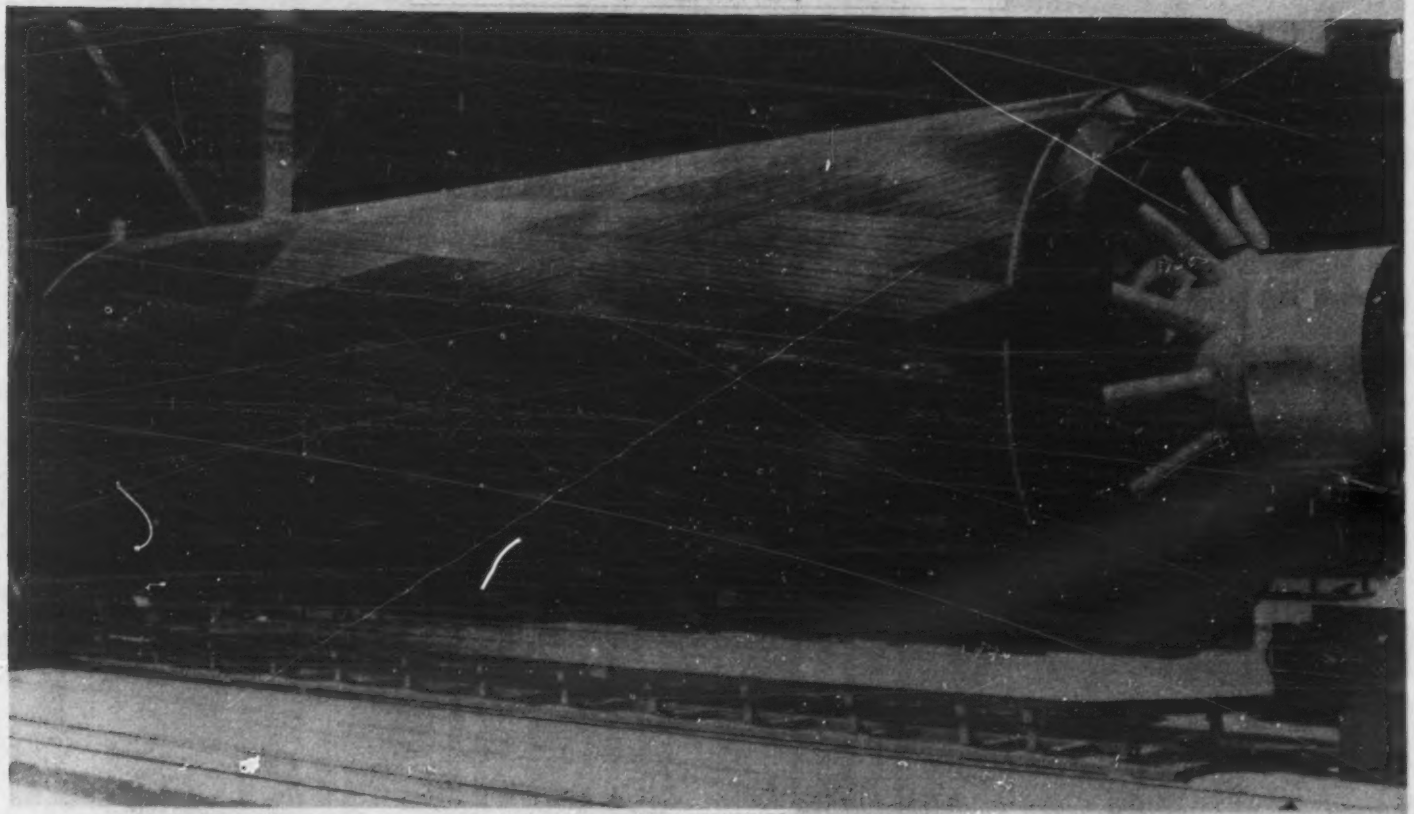


FIGURE 20

SOLID ROCKET BOOSTER

KEY PROJECT EMPHASES

- CONTINUE DEVELOPMENT AND CERTIFICATION OF RECOVERY AND REUSE PROGRAMS – COMPLETE IN 1983
- VEHICLE PERFORMANCE ENHANCEMENTS
  - LIGHTWEIGHT CASE
  - HIGH PERFORMANCE MOTOR
  - FILAMENT WOUND CASE
- ATTAINMENT OF PRODUCTION RATE CAPABILITY
  - TOOLING
  - FACILITIES
  - PRODUCIBILITY
  - PRODUCTION READINESS
  - SUBCONTRACTORS
  - OFF–SITE BOOSTER ASSEMBLY FACILITY
- COST REDUCTION
  - REQUIREMENTS
  - PRODUCIBILITY
  - INCENTIVE CONTRACTING

FIGURE 21

SPACE SHUTTLE MAIN ENGINE PROJECT

- PROJECT SUMMARY
- ACCOMPLISHMENTS
- FY 82 ACTIVITIES
- KEY PROJECT EMPHASES

FIGURE 22

SPACE SHUTTLE MAIN ENGINE
PROJECT SUMMARY

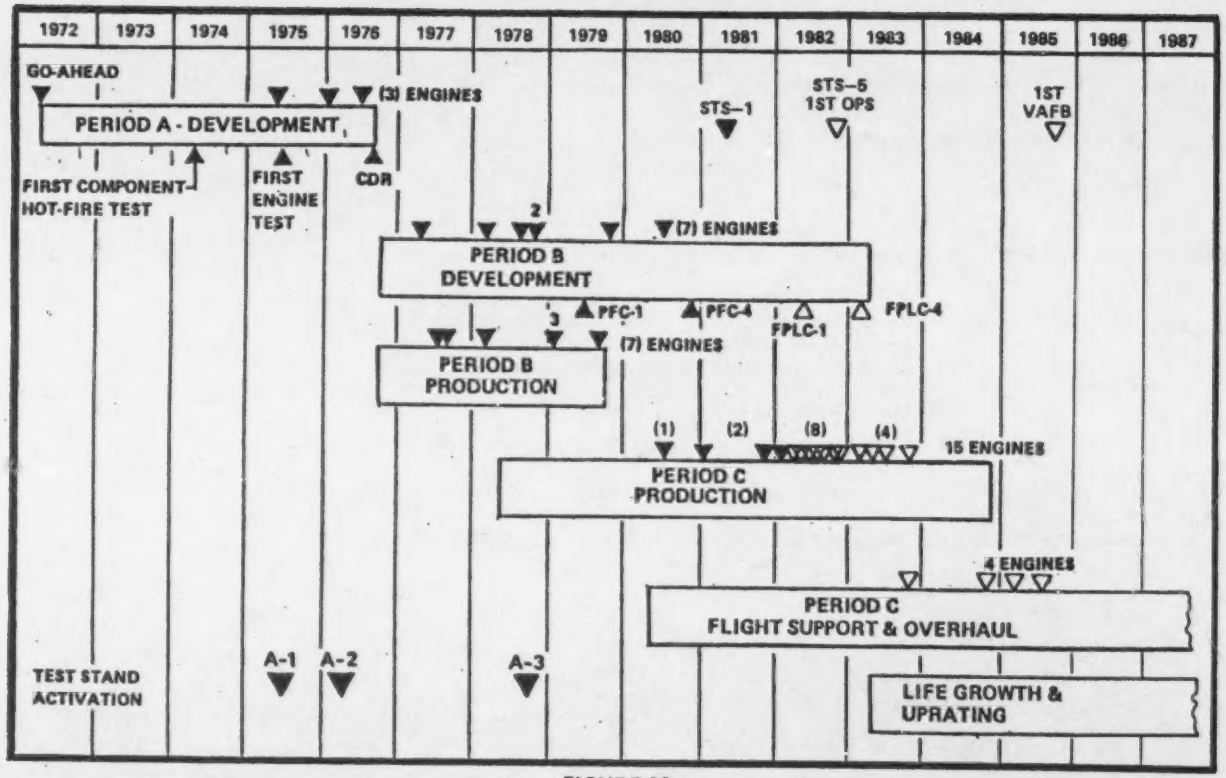


FIGURE 23

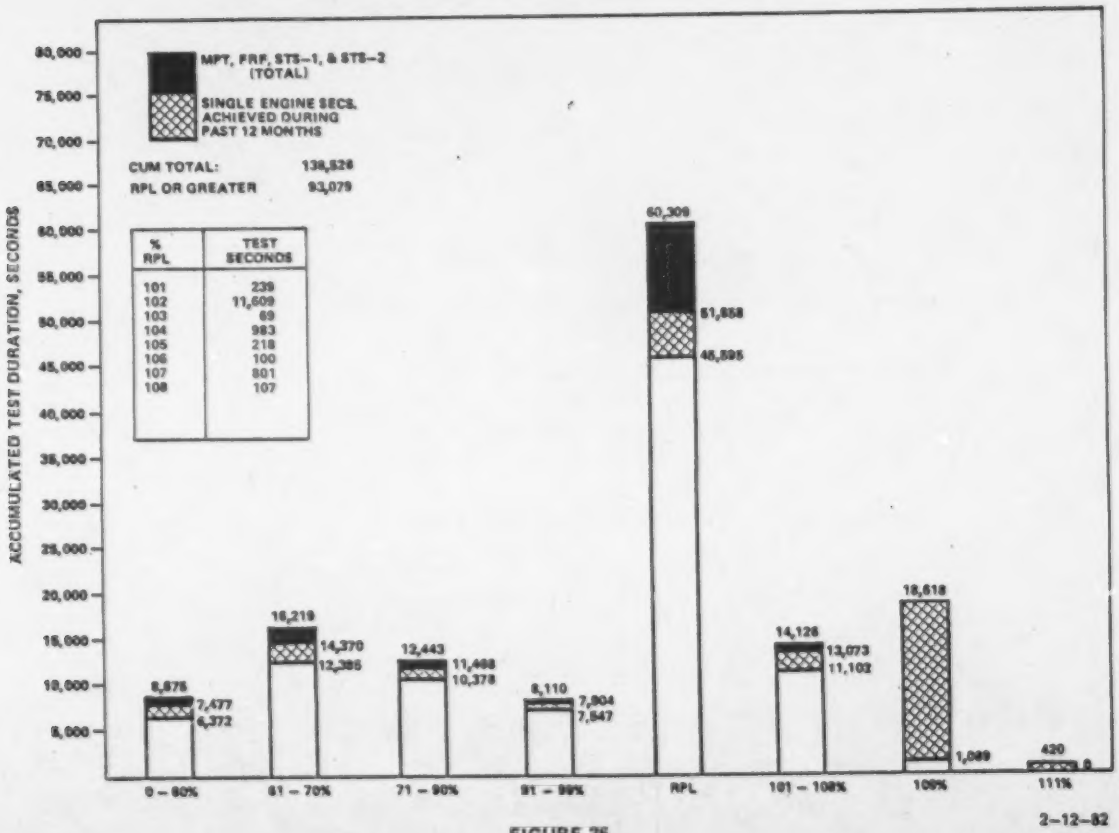
SPACE SHUTTLE MAIN ENGINE
ACCOMPLISHMENTS

- DDT&E
  - REUSED LARGE FLIGHT ENGINES FOR THE FIRST TIME IN THE SPACE PROGRAM
  - COLUMBIA FLIGHT ENGINE EXPERIENCE EXCELLENT
    - NO FLIGHT PROBLEMS ENCOUNTERED
    - MAINTENANCE CAPABILITY DEMONSTRATED
    - ENGINE REUSEABILITY DEMONSTRATED
  - CONTINUED TO DEMONSTRATE RELIABILITY – 20,000 SECONDS ON A SINGLE TEST ENGINE – 138,000 TOTAL SECONDS
  - INITIATED FULL POWER LEVEL (FPL) DEVELOPMENT ON ALL THREE TEST STANDS
    - SIGNIFICANT PROBLEMS
      - MAIN INJECTOR
      - HIGH PRESSURE FUEL TURBOPUMP (HPFTP) PRE–BURNER
      - HIGH PRESSURE FUEL TURBOPUMP (HPFTP) TIP SEAL
      - HIGH PRESSURE OXIDIZER TURBOPUMP (HPOTP) DIFFUSER VANE
    - MODIFICATIONS IN TEST

FIGURE 24

99-418 O—82——30

SUMMARY OF ENGINE TEST POWER LEVEL OPERATION



2–12–82

FIGURE 25

SPACE SHUTTLE MAIN ENGINE

ACCOMPLISHMENTS (CON'TD)

- FULL POWER LEVEL CERTIFICATION PROCEEDING
  - ENGINES 2010 AND 2012
  - FIRST SERIES – COMPLETE – ENGINE 2010
  - NO SIGNIFICANT PROBLEMS ENCOUNTERED
    - OXIDIZER TURBOPUMP (HIGH PRESSURE) BEARING LIFE AND ROTOR STABILITY IMPROVEMENTS NEEDED
- ENGINE BUILD SCHEDULES BEING MAINTAINED

FIGURE 26

FLIGHT CERTIFICATION SUMMARY

(FPL)

CERTIFICATION OBJECTIVES	CERTIFICATION CYCLE REQUIREMENTS	ENGINE 2010		ENGINE 2012	
		1ST CYCLE	2ND CYCLE	1ST CYCLE	2ND CYCLE
TOTAL TESTS	13	13			
STARTS TO RATED POWER LEVEL	13	13			
TOTAL DURATION (SEC)	5000	5026			
TIME AT FULL POWER LEVEL	3000	3039			
TIME ABOVE FULL POWER LEVEL (111%)	380	380			
MISSION DURATIONS	8	8			
NOMINAL MISSIONS (500 SEC)	6	6			
ABORT TO ORBIT (595 SEC)	1	1			
RETURN TO LAUNCH SITE ABORT (750 SEC)	1	1			
SCHEDULE COMPLETION DATES		MAY 1982	SEP 1982	OCT 1982	FEB 1983

FIGURE 27

SPACE SHUTTLE MAIN ENGINE

FY-82 ACTIVITIES

- STS–3 AND STS–4 FLIGHTS
- COMPLETE FIRST SERIES OF FPL CERTIFICATION – ENGINE 2010
- INITIATE SECOND SERIES OF FPL CERTIFICATION – ENGINE 2012
- DELIVER THE SECOND FLIGHT SET OF ENGINES – OV 099
- COMPLETE DESIGN VERIFICATION SPECIFICATION REQUIREMENTS FOR FPL
- DEMONSTRATE OPERATIONAL PROGRAM INSPECTION AND TURNAROUND REQUIREMENTS
- COMPLETE EIGHT ENGINE ASSEMBLIES – FULL POWER LEVEL

FIGURE 28

SPACE SHUTTLE MAIN ENGINE
KEY PROJECT EMPHASES

- FULL POWER LEVEL CERTIFICATION
- DEMONSTRATE ENGINE LIFE CAPABILITY
  - COST – ENGINE USES, SPARES AND MAINTENANCE REQUIREMENTS
  - RELIABILITY
- FLIGHT PROGRAM SUPPORT
  - ENGINE DELIVERIES
  - SPARE HARDWARE

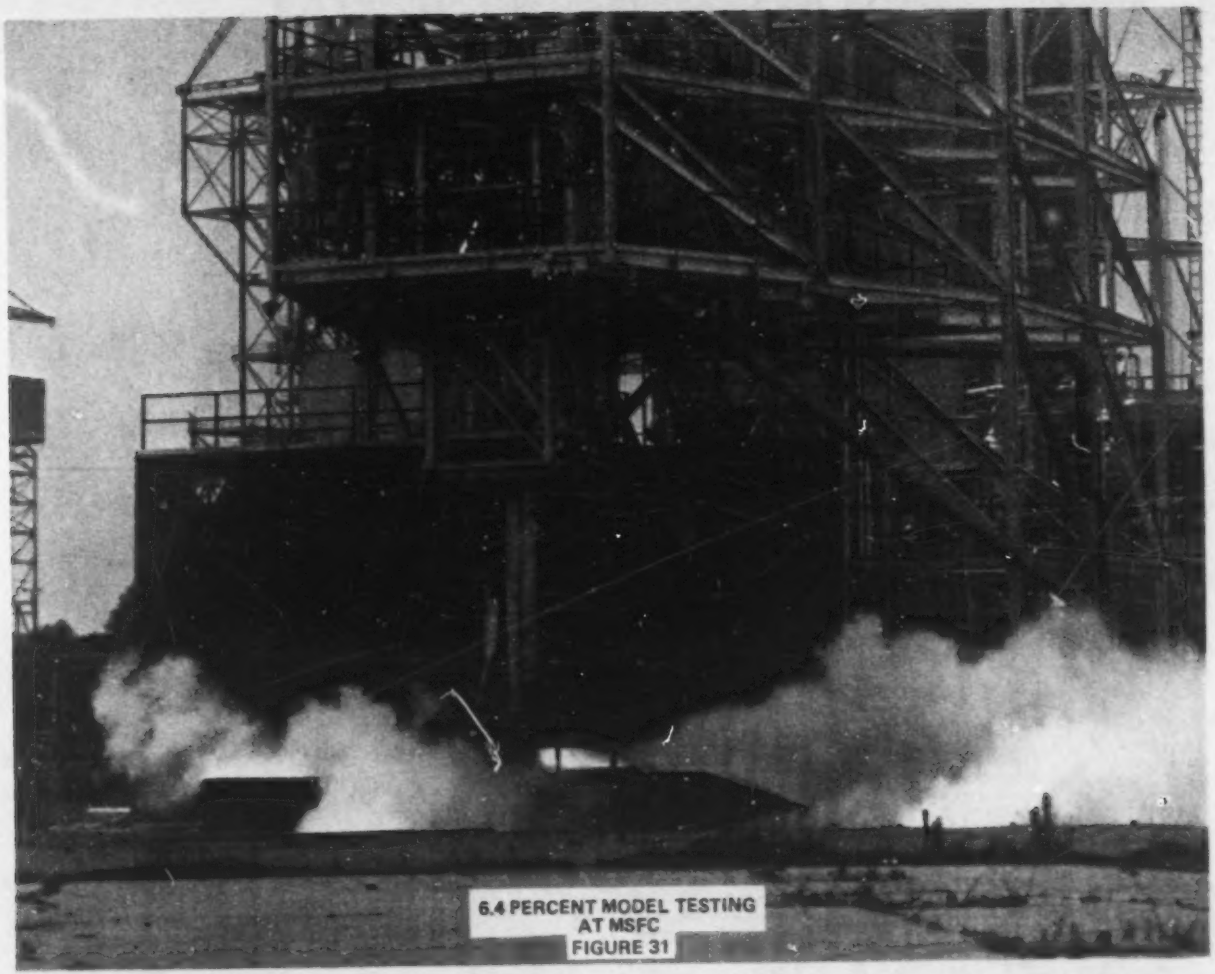
FIGURE 29

SHUTTLE SYSTEMS

ACCOMPLISHMENTS

- SUCCESSFULLY SUPPORTED STS–1 AND STS–2 LAUNCHES
  - MAIN PROPULSION SYSTEM
  - ASCENT FLIGHT SYSTEMS
  - HUNTSVILLE OPERATIONS SUPPORT CENTER (HOSC)
  - PRE–LAUNCH AND LAUNCH REQUIREMENTS
- OVERPRESSURE PROBLEM EXPERIENCED ON STS–1 RESOLVED
  - ANALYSIS
  - 6.4% MODEL TESTING
- MAIN PROPULSION TEST
  - TWO SPECIAL PROPELLANT LOADING TESTS
    - TPS ENHANCEMENT AND PROOF TESTING
- CONDUCTED STUDIES OF A PROPULSION AUGMENTATION SYSTEM TO INCREASE PERFORMANCE
- USAF ACTIVATION OF VAFB
  - REVIEWED FACILITY DESIGNS
  - PROCURED COMMON SUPPORT EQUIPMENT

FIGURE 30



6.4 PERCENT MODEL TESTING
AT MSFC
FIGURE 31

SHUTTLE SYSTEMS

FY-82 ACTIVITIES

- CONTINUE MAIN PROPULSION SYSTEM AND ASCENT FLIGHT SYSTEM ENGINEERING ANALYSIS AND INTEGRATION
- SUPPORT STS–3 AND STS–4 FLIGHTS
- SUPPORT THE ACTIVATION OF VANDENBERG AIR FORCE BASE
  - REVIEW FACILITIES, GROUND SUPPORT EQUIPMENT AND VEHICLE FLOW
  - PROCURE COMMON GROUND SUPPORT EQUIPMENT
  - OVERPRESSURE AND ACOUSTIC TESTING ASSOCIATED WITH THE VAFB LAUNCH PAD CONFIGURATION
- MAIN PROPULSION TEST
  - TWO SPECIAL LOX LOADING TESTS – VERIFY CONFIGURATION CHANGES
  - STATIC FIRING TO VERIFY PROPULSION SYSTEM AT 109% POWER LEVEL

FIGURE 32

February 12, 1982

STATEMENT
of
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MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

for the
Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

This statement introduces the Shuttle Projects Office portion of the Marshall Space Flight Center prepared testimony to the Subcommittee on Space Science and Applications. The accomplishments since the last report to the Subcommittee are summarized and the status is assessed.

The Marshall Space Flight Center (MSFC) responsibilities, include development and production of the Solid Rocket Booster (SRB), the External Tank (ET), and the Space Shuttle Main Engine (SSME). The major contractors are Thiokol at Brigham City, Utah and United Space Boosters Incorporated, Huntsville, Alabama for the SRB; Martin Marietta at Marshall's Michoud Assembly Facility, New Orleans, Louisiana for the ET; and Rockwell International, Rocketdyne Division, Canoga Park, California for the SSME. In addition, MSFC manages and directs major system level test programs, using test facilities at the Center and the National Space Technology Laboratory (NSTL), Bay St. Louis, Mississippi; participates in system level engineering and integration; conducts structural subsystem and component testing in its facilities at Huntsville, and provides vital engineering support to the launch site test and checkout activities through the facilities of the Huntsville Operations and Support Center (HOSC). In all of these activities excellent progress has been achieved.

A summary of progress in the DDT&E phase and in the Operations phase of the program is as follows:

DDT&E Summary - The MSFC Shuttle Projects have achieved a high state of development maturity as evidenced by the successful operation of these elements during the successful launches of Space Transportation System (STS)-1 and STS-2. The engines performed to specification, experienced no anomaly and maintained full redundancy throughout the flights. The External Tank performed to specification and experienced no anomaly during the boost phase, though a minor problem with the tumble valve occurred after separation on STS-1. This problem was subsequently corrected on STS-2. The Solid Rocket Boosters performed flawlessly in completing the task of boosting the Orbiter and External Tank to a height of 28 miles and a velocity of 3000 miles per hour. The boosters were successfully recovered and will be reused on subsequent Shuttle flights. Though the majority of the SRB hardware can be reused as planned, modifications will be made to the aft skirt to reduce the damage experienced during reentry and water impact. These changes will be made in the course of the program to achieve reuse and refurishment requirements and specifications.

The development program continues with emphasis on the flight objectives of STS-3 and STS-4, certification of the SSME at the full power level (FPL) of 109% thrust, and efforts to provide an increase in Space Shuttle performance: the lightweight external tank (LWT), the SRB high performance motor (HPM); and the filament wound case (FWC) for the Solid Rocket Booster, currently pending congressional reprogramming authorization. These performance improvement activities will increase the orbital payload capability by some 14,000 pounds.

Operations Summary - The MSFC Shuttle Projects activities will continue with the production of the major elements: the External Tank, Solid Rocket Booster, and the Space Shuttle Main Engine. All production requirements - tooling, facilities, and hardware are on schedule to support the mission model.

In order to assess the contractor's planning and readiness to support a 24 per year flight rate in FY-88, an initial cycle of Production Readiness Reviews (PRR's) of the External Tank and Solid Rocket Booster prime contractors has been completed. Follow-up reviews of the prime contractors and initial PRR's of the subcontractors are scheduled later this year. In addition, contractual actions are underway to provide tooling and facilities for this production rate, and to provide cost reduction incentives to the contractors.

Increased emphasis is being placed on lowering unit cost through producibility improvements and reduction of technical and performance requirements.

The completion of the development flights, STS-1 through STS-4, will confirm the primary flight environments and design requirements. The Center and its contractors will be making a concerted effort in FY-82 and FY-83 to reduce these requirements thus lowering unit cost and increasing operational effectiveness.

EXTERNAL TANK

The External Tank is nearing completion of its development program. The tank was qualified for flight by the ground testing program, and during the successful launch of STS-1 and STS-2 no anomaly occurred which would require a design change. The remaining effort concentrates on completion of the STS-3 and STS-4 flights, the lightweight tank qualification program, and a review of technical requirements to achieve the goal of reducing the manufacturing cost and increasing operational effectiveness. Of significance is a review of the requirements for the Thermal Protection System (TPS) to prevent ice formation on the tank required for Orbiter tile protection and for the ascent thermal environment.

The tank performed extremely well during the successful launches of STS-1 and STS-2. After separation from the Orbiter on STS-1, a valve designed to tumble the tank in order to control the breakup altitude and splashdown footprint did not operate; however, the tank impacted in the planned area. This anomaly was corrected and the tank tumbled properly on STS-2. A debond problem was encountered on ET-1 at KSC; but has not manifested itself on later tanks. Process control measures have been implemented at Michoud Assembly Facility (MAF) to prevent recurrence. ET-2 was shipped to the NSTL and loaded with cryogenic propellants in the Main Proplulsion test stand to verify that these measures are adequate. In addition, ET's 3 and 4 will be cryogenically loaded at Kennedy Space Center (KSC) prior to launch to complete the verification program.

Manufacturing activities have progressed on schedule this year. ET-2 was delivered to KSC in April 1981 for the STS-2 launch. The next two flight tanks were also completed and delivered to KSC (ET-3 in October 1981 and ET-4 in January 1982). This completed the tank fabrication required for the Orbital Flight Test (OFT) Program. Fabrication of operational tanks is also well underway at MAF. ET's 5 and 6 (last of the heavyweight tank configuration) are now in final assembly and will be delivered to KSC the summer of 1982. The first lightweight tank has been structurally assembled with TPS now being applied to the liquid oxygen tank, intertank and liquid hydrogen tank. This tank is scheduled to be delivered to KSC in the fall of 1982. Three other lightweight tanks are in various stages of subassembly at MAF.

The Lightweight Tank Program Critical Design Review was completed in July 1981 with the evaluation of the TPS design. The major lightweight structural test program was completed at MSFC in August 1981. Modifications to existing tooling to accept the lightweight configuration have been completed and tanks are being fabricated as previously discussed. New TPS cells and modifications to existing cells are being completed, activated, and utilized on the first lightweight tank. Contracts have been awarded for components for an additional four lightweight tanks to bring the total on contract to 15. Qualification testing of components is progressing in support of the first lightweight delivery.

In July 1981, the ET project conducted a Production Readiness Review to determine the readiness to proceed into full production. Several areas of concern were identified relative to both the contractor and the government with actions being assigned to eliminate these concerns.

The producibility program has continued and is beginning to provide the expected results. Candidates are being identified, developed, and implemented in support of the project's goals of reducing unit cost. Several candidates such as injection molding of ablator components have been implemented on the first lightweight tank and are producing reductions in the fabrication effort required.

SOLID ROCKET BOOSTER

The Solid Rocket Booster Project has successfully demonstrated the design maturity and reuse capability of the Solid Rocket Boosters. The boosters performed flawlessly during the boost phase of the STS-1 and STS-2 flights. There was no anomaly that required redesign or requalification. During the atmospheric reentry, water entry, and recovery phases of the flight, some damage to the aft skirt assemblies was experienced. Design modifications to reduce this damage have been initiated and will be introduced in subsequent tests. The program to develop and meet the reuse and refurbishment requirements, planned for completion during the early flight program, will be somewhat impacted as will the processing time for the initial flights to use refurbished hardware.

Hardware deliveries and engineering continue to fully support the STS-3 and STS-4 launches on schedule. The remainder of the development effort is concentrating on providing additional payload capability with the HPM and developing plans for use of a FWC in lieu of the all steel case for missions requiring the higher payload capability. This proposed FWC change will provide an additional payload capability of about 6,000 pounds.

In preparation for the production phase, Production Readiness Reviews to demonstrate the capability for increased hardware production rates, were held at the prime contractor facilities this past year. In addition, extensive technical evaluations of prime contractor annual hardware procurements (STS-7 and subsequent) were conducted.

Following the STS-1 flight, a hardware reuse and an STS-1 "lessons learned" review was conducted to identify potential redesigns to improve producibility and reduce launch site hardware turnaround times. As a result of this review, design and process changes are being incorporated to reduce process time and cost. Special attention is being given to the SRB system tunnel and TPS areas with these improvements being planned for an STS-17 effectivity.

SPACE SHUTTLE MAIN ENGINE

The flight of STS-1 capped a decade of technology advancement and propulsion system development for the successful Space Shuttle Main Engine. This performance was duplicated during the STS-2 mission, marking this nation's first space reuse of a large liquid rocket engine propulsion system. The true measure of the design reusability of the SSME was

reflected in the minimal maintenance required between flights and rapid propulsion system turnaround. Preparation for the STS-3 mission is proceeding as planned with some schedule improvement evident in between flight servicing.

Although major project attention was focused during the past year on the preparation for STS missions, substantial progress has been evident in development of the SSME at full power level (FPL) thrust and achieving extended life in the engine components. The initial development testing evidenced significant problems in the engine main injector, high pressure fuel turbopump pre-burner, and in the high pressure oxygen turbopump diffuser vane. These problems were associated with fatigue life at the 109% thrust level. Design modifications have been introduced and the early testing points to a successful resolution of these problems. During this period, seven engines (serial numbers 0006, 0008, 0204, 2108, 0110, 2010, and 0107) have undergone development testing to achieve these goals. An additional 33,500 seconds of engine operation has been accumulated during 140 tests with over 17,000 seconds of operation conducted at the full thrust conditions. Certification testing for the full power thrust condition is proceeding on engine serial no. 2010 with completion of one of the four required demonstration cycles approximately two months ahead of schedule. The second certification cycle is scheduled to begin within the next month on engine serial no. 2012, which is currently at the test site awaiting availability of a test position. One of the full power thrust development engines, serial no. 0107, has now accumulated in excess of 7,000 seconds of operation with 5,600 seconds at full thrust conditions.

Engine fabrication for Orbiter Vehicle 099 and subsequent vehicles is proceeding on schedule. The three engines for Orbiter Vehicle 099 are in the final stages of assembly and will be completed on one month intervals during the next quarter. Delivery of these engines to KSC is scheduled for August 1982 after acceptance testing and main propulsion system testing.

SHUTTLE SYSTEMS

The MSFC systems efforts include system engineering and analysis of the Shuttle Main Propulsion and Ascent Flight Systems and specification of MSFC requirements for Launch Operations at KSC and Vandenberg Air Force Base (VAFB) to provide real time support to these operations. The systems activity also includes responsibility for main propulsion system testing at NSTL and the accomplishment of systems studies to define performance enhancements and operational improvements.

A significant systems analysis and testing effort was completed to resolve an STS-2 launch constraint, identified during the launch of the first Space Shuttle in the form of a pressure pulse experienced on the Orbiter's wings and elevons. The pulse occurred several milliseconds after Solid Rocket Booster ignition, when pressure waves from the boosters reflected up through openings in the Mobile Launch Platform. MSFC worked in conjunction with Johnson Space Center (JSC), Kennedy Space Center (KSC), and the Shuttle

contractors to determine a method of reducing these excessive loads on the Shuttle Orbiter. MSFC used a 6.4% scale model of the Orbiter, Tomahawk rockets to simulate the boosters and a scaled-down version of the mobile launcher to test potential corrective changes that might be applied to the launch facility. This in-house testing at MSFC empirically identified methods to suppress the ignition overpressure and the second Shuttle flight verified that the modifications did reduce the overpressure to an acceptable level. Tests at MSFC will also be performed with the Vandenberg launch facility configuration to determine the pad configuration necessary to prevent unacceptable overpressure during launches from the Western Test Range (WTR). Also, acoustic tests are planned at MSFC with the WTR configuration.

Two special propellant loading tests for ET TPS enhancement were successfully accomplished. Two MPTA ET tumble valve tests (ambient and cryogenic) were successfully accomplished to provide data for resolution of the STS-1 problem where the valve failed to operate. A special pneumatic proof test was successfully accomplished on the MPTA ET liquid hydrogen tank for structural verification following completion of tank corrosion arrest. Two special liquid oxygen (LOX) loading tests are scheduled for March 1982 to develop: (1) Level control configuration at nominal and minimum ullage, (2) procedures for geyser avoidance, (3) LOX stabilization time, and (4) minimum ullage to allow future performance improvement. Planning is in progress for MPT static firings for the main propulsion system verification of the engines at full power level (109%).

Studies conducted to define a performance augmentation system for Shuttle polar orbits flown from the WTR were concluded with the SRM Filament Wound Case selected as the best alternative. If the FWC receives congressional reprogramming authorization, which is currently pending, the case design will be initiated in May 1982.

Increased emphasis is being required to support the initial operational capability at VAFB. In-house and contractor reviews are being conducted of the VAFB ground facilities to assure compatibility between the facilities and the launch vehicle. A substantial effort is also underway to procure common support equipment for VAFB.

The Huntsville Operation Support Center supported real time trouble-shooting during the STS-1 and 2 launches. HOSC completed flight evaluation of these launches, identified and implemented program requirements for OFT flights and established the data systems for future prelaunch support and evaluation of flights. HOSC remains in the posture to support the scheduled launches for 1982 and are working the program requirements for Operations and VAFB.

In summary, excellent progress has been made since the last report to the Subcommittee. In FY-82, an extremely high percentage of work was accomplished for the planned cost. The performance during the STS-1 and STS-2 flights, and the current progress in hardware production, tooling, and facilities are evidence that the Center and its contractors will support the operational program. The ability to provide improvements to the ET and SRB signifies the progress being made to improve the Shuttle payload capability which is of major significance to the operational missions. Upon completion of the flight test program, it is expected that requirements will be reduced and subsequently result in the attainment of a lower unit cost and improvement of the systems overall operational effectiveness. A vigorous effort toward this goal will be continued during FY-82 and FY-83.

TRANSCRIPT OF TESTIMONY

by

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SPACE TELESCOPE PROJECT OFFICE
MARSHALL SPACE FLIGHT CENTER

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
of the
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

February 12, 1982

DR. SPEER: Mr. Chairman, Chairman Fuqua, Ladies and Gentlemen, I have prepared a formal statement for the record, and with your permission I would like to summarize briefly the highlights and progress and status of the Space Telescope Project.

CHAIRMAN FLIPPO: Very good, please feel free to summarize as you deem appropriate.

DR. SPEER: First, I will briefly discuss all the essential elements of the project, as shown in this artist concept (Figure 1). As you can see, the observatory (Space Telescope) is pointing at a star, and communicating with the Tracking and Data Relay Satellite, which in turn transmits the observing data to the ground receiving station. Of course, commands from the ground station are being transmitted to the observatory for the next stage of the observing program. The information received at the ground station is further transmitted to the control center at Goddard Space Flight Center, and from there the data will be sent, within 24 hours, to the Science Institute located at Johns Hopkins University. The end product

of this entire chain of events is science data in the form of images, spectrograms, and so forth. The Space Shuttle is shown in the lower left corner of the figure and is used as a means of transportation to launch the Space Telescope and deploy it in orbit, as well as, revisits for maintenance in orbit and, if required, return the Space Telescope to the ground for maintenance and refurbishment.

We believe that the Space Telescope is the most exciting and most significant space science project that the Agency has ever undertaken. As can be seen in this artist's concept, (Figure 2), without any aids, the human eye can see 600,000 light years into space. As we utilize the most sophisticated ground telescopes and instruments, we are able to discern light sources and stars as far as two billion light years away. However, with the Space Telescope in space, where there is no observing distortion due to atmosphere, the distance we can see will be seven times greater, so we will magnify the volume of space that will be available to us for observations by a factor of 350. This means that there are a lot of things that we have never seen before that we will be able to observe with the Space Telescope in orbit.

We expect the image resolution and ability to distinguish details in space will increase ten times, and we will see objects that are 50 times fainter than what we can presently see from Palomar Mountain or other similar observatories and, of course, we will also be able to see farther into the ultraviolet and the infrared, the invisible part of the spectrum that also contains very important information on the stars.

The configuration of the Space Telescope is shown in this artist's concept (Figure 3), and I will utilize this picture as I explain the responsibilities assigned to the

various organizations involved in the Space Telescope Project as shown in Figure 4. Our Center, Marshall Space Flight Center, is responsible for project management. The Lockheed Missiles and Space Company is responsible for developing and designing the Support Systems Module, which includes the outer shell, the equipment section, which further includes all the important components and subsystems for thermal control, pointing control, and so forth. The Perkin-Elmer Corporation is responsible for the Optical System which includes the main ring, the fine guidance sensors and the focal plane structure, which houses the four axial Scientific Instruments. The Scientific Instrument that is shown on the bottom of the figure is the single radial instrument, a camera being developed by the Jet Propulsion Laboratory.

The Solar Arrays are being developed by the European Space Agency, together with one of the axial instruments, the Faint Object Camera. The Solar Arrays include the electronics and mechanisms used to drive the solar array elements to face the sun, as the orientation of the Space Telescope is changed from one observation to another. The Solar Arrays will always be pointed at the sun, as they are the primary source of electrical power.

Goddard Space Flight Center is responsible for the day-to-day management of the scientific instruments and is developing the ground operations system that will be utilized to operate the Space Telescope in orbit.

Johnson Space Center is responsible for the Space Shuttle crew interface, and this is of par cular importance for the maintenance in orbit and our preparations for those activities.

Kennedy Space Center is, of course, responsible for launch

operations.

The Master Schedule for the Project is shown in this chart (Figure 5). Approval was granted to start the Project in July 1977. We are well beyond the mid-point on our way to launch in early 1985. The schedule shows the major project elements; for example, the Optical Telescope Assembly which is a Perkin-Elmer effort, and the Support Systems Module, which is a Lockheed effort. We have completed essentially all design reviews with the exception of the Support Systems Module at Lockheed. In this regard, we have more than half of the subsystems reviews behind us and are scheduled to complete this design review next month.

The next major step in 1983 is to receive all hardware and to start our overall systems test after assembly of the Space Telescope as a whole, and after about a year of systems testing, we intend to launch.

CHAIRMAN FLIPPO: Are you confident that you have the technical problems solved with the telescope?

DR. SPEER: I believe, Mr. Chairman, that we have resolved all the major problems that confronted us in the beginning, in particular with regard to the pointing control system. The system requirements are very high, we are expected to provide a stability with this telescope to make observations of faint stars in such a way that we may not deviate, in a 24-hour period, more than a hundredth of an arc second. Now to give you an idea of what that equates to, if you were to look from Washington to Boston and sight on a dime we put in Boston, you would not be permitted to deviate any outside the dime's area. This is what 0.01 arc seconds means. Our system, to the best of our knowledge, based on analysis, will support that

requirement.

CHAIRMAN FLIPPO: Are you confident that you understand the cost aspects to completion?

DR. SPEER: Yes, Sir. We believe we understand the cost of satisfying the program requirements and believe we will be able to finish the Space Telescope development within the limits given to us.

I would like to show you now, item by item (Figure 6), the major progress we made during the last year, and to show in a few pictures what these items look like, starting with the Optical Telescope Assembly at Perkin-Elmer. We have completed our primary mirror, which is the single most important element of this telescope, an accomplishment of which we are particularly proud. This is the Coating Chamber (Figure 7) that was used to coat the mirror with an aluminum layer after polishing, and what is shown here is a tool that is placed on the facility in lieu of the mirror just prior to moving the mirror into the chamber. This is one of three pumps, cryo pumps, that provide a very high vacuum. This is the mirror (Figure 8), shown, in December last year, right after coating, and you can see the large size, 2.4 meters. The mirror accuracy is such that it will support the requirements that I have just explained to you. This is probably the finest mirror of this size in the world today.

We are now starting to assemble the various major subassemblies that constitute the Optical Telescope Assembly, you can see two items (Figure 9), the main ring and the metering truss structure. The metering truss is a graphite epoxy structure used to maintain a precise distance between the primary and secondary mirrors at all temperatures. Graphite Epoxy has almost no expansion as a

function of temperature, so it is the ideal material for this application, however, it is an exotic material that gives us some concerns about load carrying capabilities. It is not what you would like to use unless you have to, and it appears this is one occasion where we have to use it. It is mounted to a titanium ring structure that is really the backbone of the telescope. The ring structure will carry the main mirror on one side and on the other side the focal plane structure, which in turn houses the instruments. This particular configuration was mated to the metering truss structure in order to perform a test that would give us the structural modes that would be experienced in orbit and also during launch. This is in part an answer to your question on how confident are we that we can meet the requirements. It is important for us to understand the structural modes in order to perform an overall pointing control systems performance assessment.

The focal plane structure (Figure 10) is also fabricated out of graphite epoxy, again because of its near zero expansion as a function of temperature. Two scientific instruments, each about the size of a phone booth, will be mounted on one side of the vertical plate and two instruments on the opposite side. The structure will be mounted, with these feet, to the main ring. As you can see, all these major elements are now complete. The focal plane structure was manufactured at Boeing.

Our European friends have made good progress also. This is an engineering model (Figure 11) of the solar array. It is one of the two solar array wings that you saw earlier on the configuration drawing. It is a roll-up solar array; rolled-up on this axis. During the launch phase, it will be rolled-up and swung back to the Space Telescope so that the whole observatory looks like a cylinder. After launch to orbit, it will be deployed away from the

SUMMARY

- PROGRESS EXCELLENT
- TECHNICAL PERFORMANCE AND PRODUCTION CAPABILITY WILL SUPPORT SPACE SHUTTLE OPERATIONAL MISSIONS
- PROGRAMS IN PLACE TO IMPROVE OPERATIONAL EFFECTIVENESS
  - IMPROVE PAYLOAD CAPABILITY
  - REDUCE COST
  - SIMPLIFY LAUNCH SITE OPERATIONS

FIGURE 33

telescope and rolled-out. This first portion, in the foreground, is actually carrying solar cells, while the remainder is carrying simulated solar cells. This was a test to study how well the motors can deploy the solar array wing.

The Scientific Instruments (Figure 12), of course, are in the forefront of our current activities, because they will be needed first, as plans call for these instruments to be tested at Goddard, after completion, one at a time, prior to being delivered to Lockheed for installation into the telescope. The High Speed Photometer (Figure 13), is the instrument that is nearest to completion. The instrument major hardware development tests have started. Software development is progressing very well. In two cases, i.e., the High Speed Photometer and the European Faint Object Camera, we are well into assembly of the flight hardware. These instruments should be delivered about a year from now to Goddard for the testing I mentioned earlier. Each instrument contains a remote interface unit which makes it talk to a central computer which in turn talks to the spacecraft computer; the interface units have all been delivered.

In the meantime, last year was an important one to get our ground system into sync with the spacecraft development, (Figure 14). The major contract you see here, Science Institute, was awarded to the Association of Universities for Research in Astronomy (AURA). Their proposal contained the decision to put this Institute at Johns Hopkins. The first Director has been named, Dr. Giacconi, whom we all know very well from HEAO days, and last fall construction of the building was started. This is a facility constructed under the auspices of Johns Hopkins and will be leased to NASA for as long as we need it. It is dedicated to the Space Telescope and we do not pay for

the construction.

The mission operations, as with spacecraft development, has various elements in different phases of design and development. We have software to be developed, and we have to develop a science operations ground system, which is really the link with the Science Institute, which will identify and formulate observing programs. This system will translate these programs into observing sequences that can be utilized to control the science operations on board the observatory. The last major mission operations contract was just recently awarded early this month to Lockheed.

CHAIRMAN FLIPPO: Let's go back to the construction of facilities up there. NASA doesn't pay for the construction of facilities. What does NASA pay for?

DR. SPEER: NASA pays an annual fee of $900,000 a year for the use of the facility and equipment in it.

CHAIRMAN FLIPPO: OK, so it doesn't put the upfront money but it does pay for the facilities in the long haul?

DR. SPEER: Yes sir, in the long haul it will.

CHAIRMAN FUQUA: Pay me now or pay me later.

DR. SPEER: I think it is a lot easier for us to pay later.

Maintenance and Refurbishment (Figure 15) is the third major element of the project, and which, by the nature of its objective, is the latest element we will start. We have started planning in this area, and we will start budgeting the maintenance and refurbishment line items

next year, FY-83. Of course, of importance here is the question of how often will we have to revisit, what kind of components are we likely to have to replace, how do we develop a logistics for all this, and do we have to bring the Space Telescope back to the ground. In this latter event, where would we refurbish and where would we maintain? We have identified some 23 components that are, as we call it, orbital replacement units, and of course, we will be ready to replace those most likely to fail first.

CHAIRMAN FUQUA: How often do you think you will have to revisit?

DR. SPEER: That is a somewhat open question, of course. Thinking of past satellites, they usually live longer than our predicted lifetime. We must be prepared to go back 2 1/2 years after launch, and then again 5 years after launch, and then 7 1/2 years. We are confident that this schedule is very conservative and we will not have to revisit that many times. Any time you go and visit the observatory in orbit, the Astronaut has to open doors and expose the optics, of course, and take some risks.

MR. BRANSCOME: Will you be launched at the time of Halley's comet?

DR. SPEER: Yes, Sir. One of the basic objectives is we are trying to keep our launch in 1985 associated with Halley's Comet, and, of course, our astronomers want to see it coming and going so, of course, we can't waste too much time.

My last chart (Figure 16) shows you our plans for next year. The most important immediate task we have is to complete our design review of the support systems module at Lockheed, which includes a critical review of all

systems; not only that we have this piece of hardware that Lockheed manufactures, Lockheed is also responsible for systems integration and this critical review will address and verify design of the entire system. We will be starting the integration of the Optical Telescope Assembly at Perkin-Elmer and you have seen the early steps to that; Scientific Instruments assembly and functional tests will continue on each of the instrument development sites just prior to delivery to Goddard about a year from now, March-April next year. The Operations Ground Systems and Science Institute design reviews will have been completed by that time, and we expect to award a contract on Maintenance and Refurbishment.

CHAIRMAN FLIPPO: Who are the main contractors in that refurbishment contract - you've got an RFP out?

DR. SPEER: We are planning to put the RFP out soon and award the contract at the end of this year.

That completes my statement.

[Figures 1-16 of Dr. Speer's oral presentation follow:]

FIGURE 1

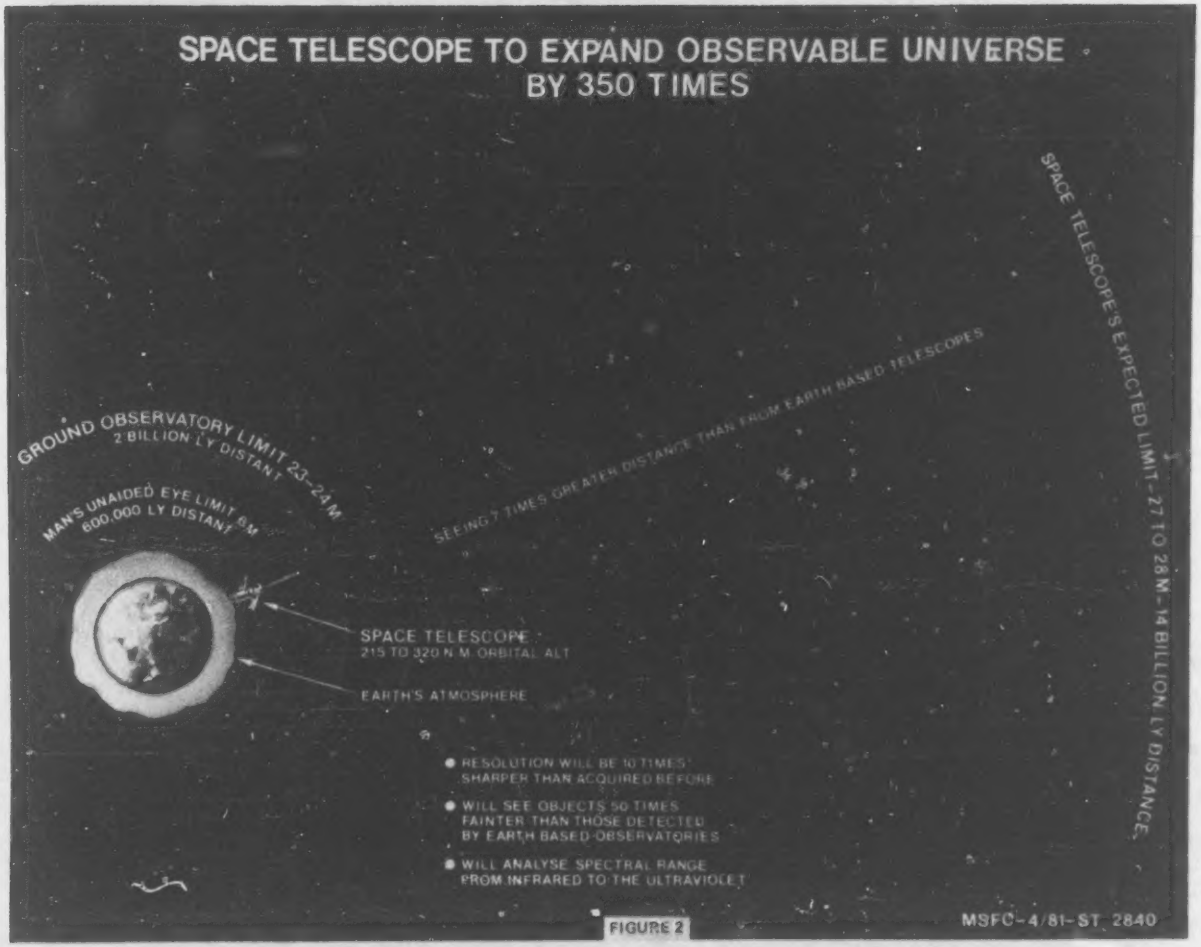
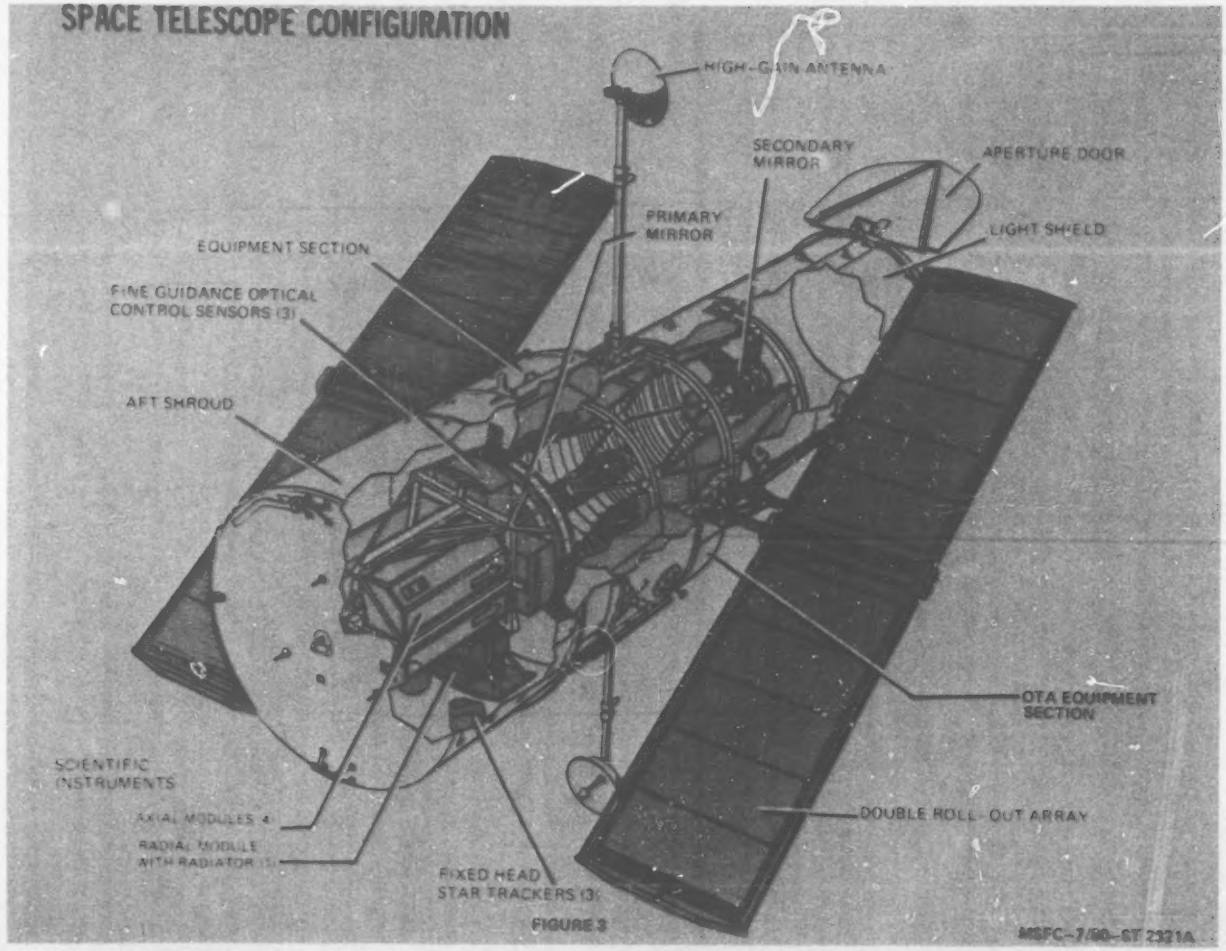

SPACE TELESCOPE TO EXPAND OBSERVABLE UNIVERSE BY 350 TIMES
SPACE TELESCOPE'S EXPECTED LIMIT–27 TO 28M–14 BILLION LY DISTANCE
SEEING 7 TIMES GREATER DISTANCE THAN FROM EARTH BASED TELESCOPES
GROUND OBSERVATORY LIMIT 23–24M
2 BILLION LY DISTANT
MAN'S UNAIDED EYE LIMIT 6M
600,000 LY DISTANT
SPACE TELESCOPE
215 TO 320 N M ORBITAL ALT
EARTH'S ATMOSPHERE
• RESOLUTION WILL BE 10 TIMES SHARPER THAN ACQUIRED BEFORE
• WILL SEE OBJECTS 50 TIMES FAINTER THAN THOSE DETECTED BY EARTH BASED OBSERVATORIES
• WILL ANALYSE SPECTRAL RANGE FROM INFRARED TO THE ULTRAVIOLET
MSFC–4/81–ST 2840

FIGURE 2


SPACE TELESCOPE CONFIGURATION
HIGH-GAIN ANTENNA
SECONDARY MIRROR
APERTURE DOOR
PRIMARY MIRROR
LIGHT SHIELD
EQUIPMENT SECTION
FINE GUIDANCE OPTICAL CONTROL SENSORS (3)
AFT SHROUD
OTA EQUIPMENT SECTION
SCIENTIFIC INSTRUMENTS
AXIAL MODULES 4
RADIAL MODULE WITH RADIATOR (1)
FIXED HEAD STAR TRACKERS (3)
DOUBLE ROLL-OUT ARRAY
FIGURE 3
MSFC-7/80-ST 2321A

SPACE TELESCOPE PROJECT RESPONSIBILITIES

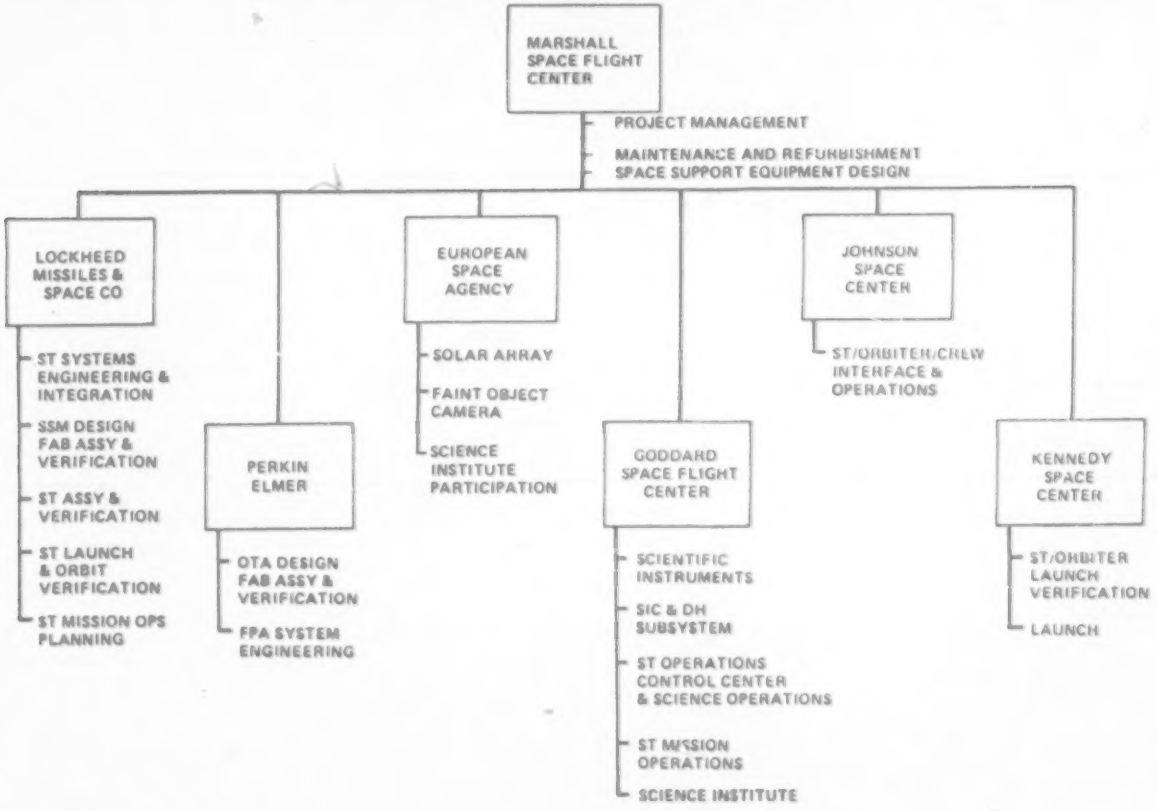


FIGURE 4

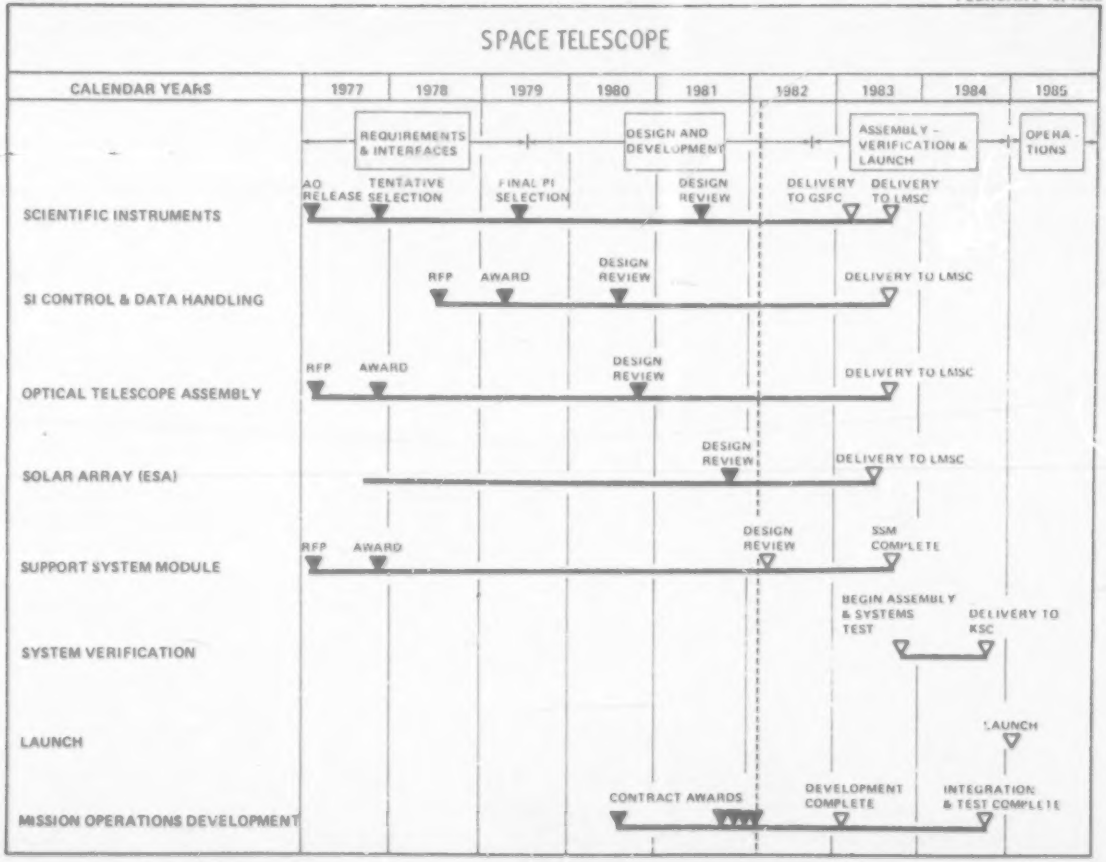

SPACE TELESCOPE
CALENDAR YEARS
1977
1978
1979
1980
1981
1982
1983
1984
1985
REQUIREMENTS & INTERFACES
DESIGN AND DEVELOPMENT
ASSEMBLY - VERIFICATION & LAUNCH
OPERA - TIONS
SCIENTIFIC INSTRUMENTS
AO RELEASE
TENTATIVE SELECTION
FINAL PI SELECTION
DESIGN REVIEW
DELIVERY TO GSFC
DELIVERY TO LMSC
SI CONTROL & DATA HANDLING
RFP
AWARD
DESIGN REVIEW
DELIVERY TO LMSC
OPTICAL TELESCOPE ASSEMBLY
RFP
AWARD
DESIGN REVIEW
DELIVERY TO LMSC
SOLAR ARRAY (ESA)
DESIGN REVIEW
DELIVERY TO LMSC
SUPPORT SYSTEM MODULE
RFP
AWARD
DESIGN REVIEW
SSM COMPLETE
SYSTEM VERIFICATION
BEGIN ASSEMBLY & SYSTEMS TEST
DELIVERY TO KSC
LAUNCH
LAUNCH
MISSION OPERATIONS DEVELOPMENT
CONTRACT AWARDS
DEVELOPMENT COMPLETE
INTEGRATION & TEST COMPLETE

FIGURE 5

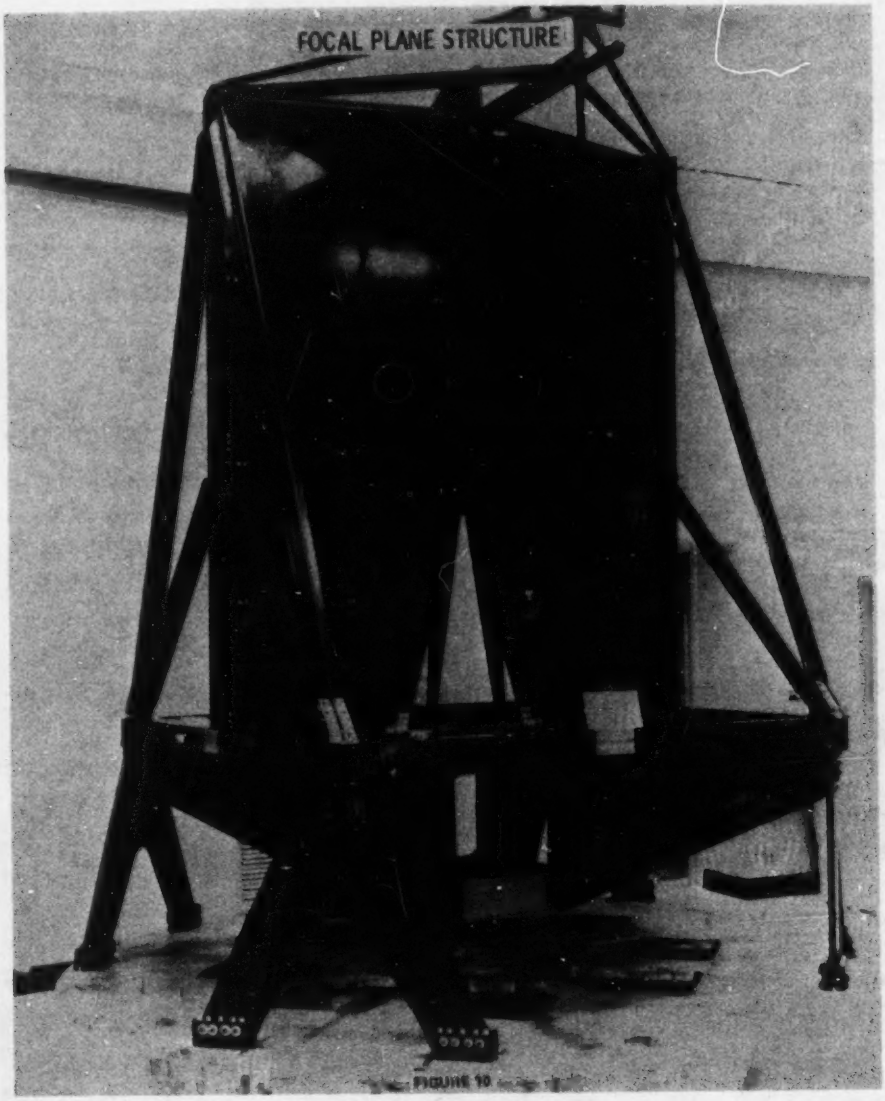


FIGURE 10

SPACE TELESCOPE PROJECT

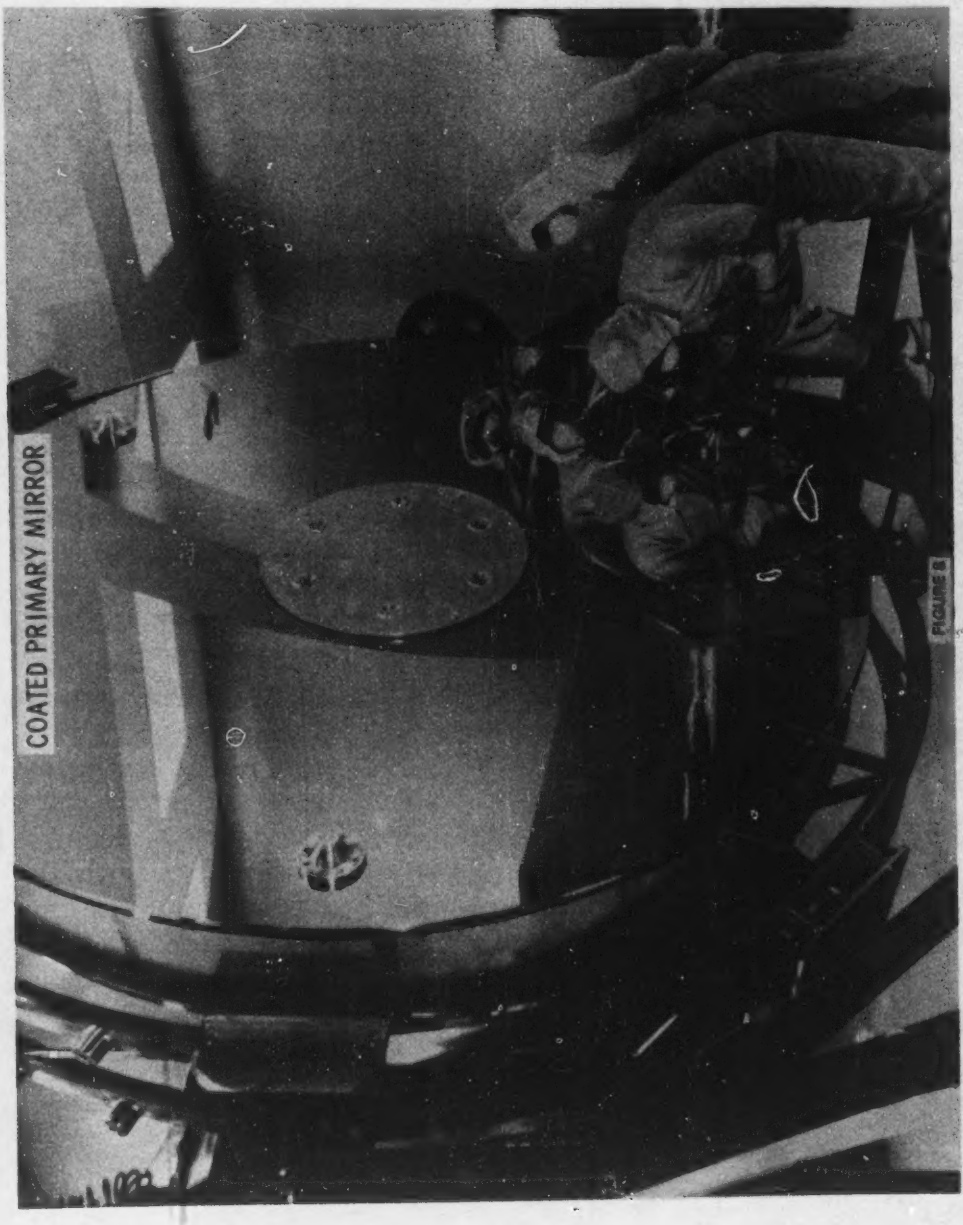
STATUS

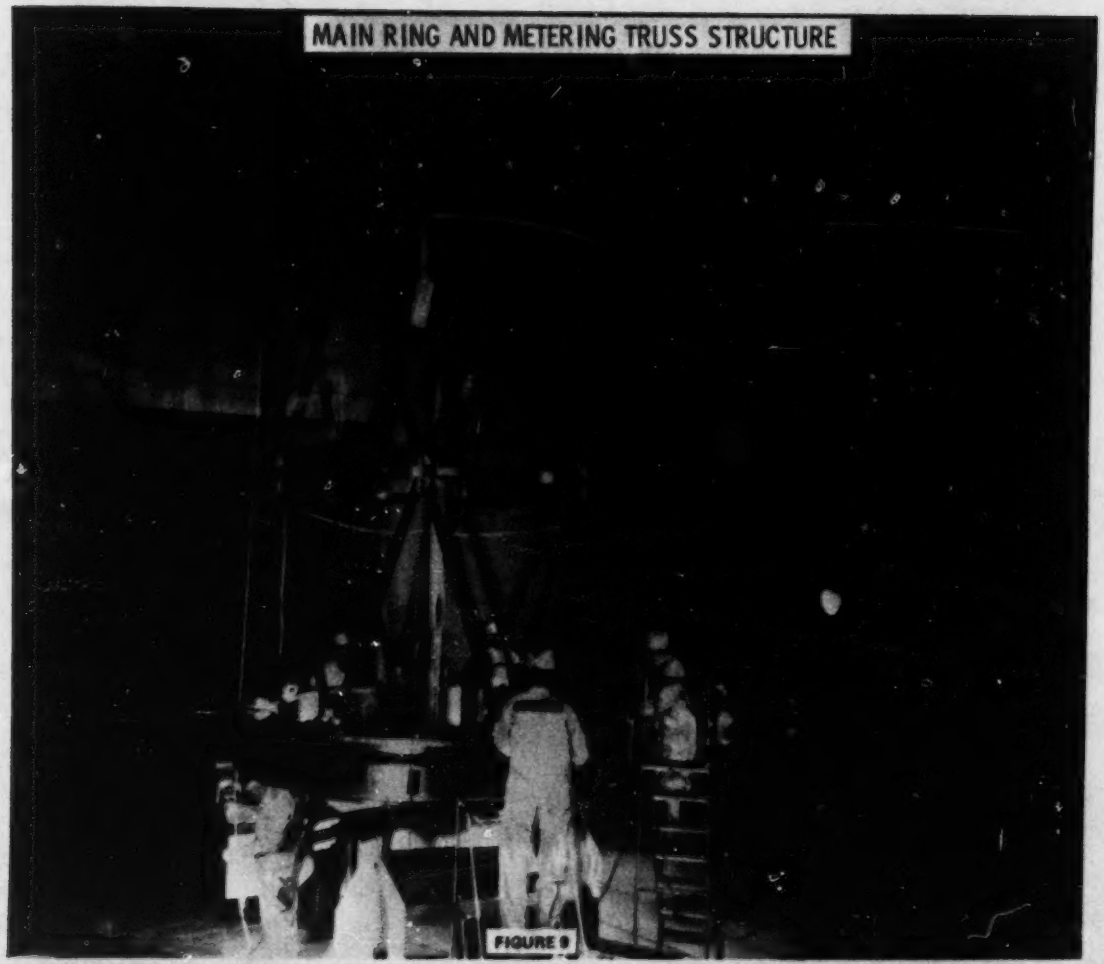
- OPTICAL TELESCOPE ASSEMBLY
  - PRIMARY AND SECONDARY FLIGHT MIRRORS POLISHED AND COATED
  - MAJOR STRUCTURAL ELEMENTS FABRICATION COMPLETED
  - MAJOR DEVELOPMENT TESTS STARTED
- SUPPORT SYSTEMS MODULE
  - CRITICAL DESIGN REVIEWS NEARING COMPLETION
  - INTERFACE CONTROL DOCUMENTS BASELINED
    - UNDER GOVERNMENT CONFIGURATION CONTROL
  - MAJOR SUBCONTRACTOR SUBSYSTEMS AND COMPONENTS RECEIVED
  - MAJOR DEVELOPMENT TESTS STARTED
  - POINTING CONTROL SYSTEM DEFINED
- SOLAR ARRAYS - PROVIDED BY ESA
  - FABRICATION OF FLIGHT HARDWARE STARTED
  - ELECTRONICS DESIGN ESSENTIALLY COMPLETE

FIGURE 8

PRIMARY MIRROR COATING CHAMBER

FIGURE 7


COATED PRIMARY MIRROR
FIGURE 8


MAIN RING AND METERING TRUSS STRUCTURE
FIGURE 9

ST SOLAR ARRAY
FIGURE 11
NASA - MSFC

February 12, 1982

STATEMENT

of

DR. FRED A. SPEER
MANAGER, SPACE TELESCOPE PROJECT

SPACE TELESCOPE PROJECT OFFICE
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

for the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

This statement presents the status of the Space Telescope Project through February 1982. It includes descriptions of major project accomplishments, and major activities planned for the coming year. Figure 1 shows the Space Telescope configuration with its major elements. A specific description of the configuration is not included since it is essentially the same as described in previous testimony to the Subcommittee.

The Space Telescope is being developed as a general purpose astronomical observatory in space with an anticipated lifetime of more than a decade. After launch to orbit by the Space Shuttle, the Space Telescope will be the first long term, national astronomical observatory in space. In fact, the Space Telescope will be an international astronomical observatory, as participation by scientists from other countries is now in the planning stage. The availability of the Space Shuttle will allow the Shuttle crew to perform selected in-orbit repair of the observatory and the exchange of scientific instruments, and, if necessary, return the entire observatory to earth for refurbishment and subsequent re-launch to orbit.

The Space Telescope will represent a tremendous step forward from the largest existing groundbased telescopes, and its existence will represent a gain similar to that of Galileo's first astronomical telescope. It is anticipated that many of its discoveries will be just as significant, for it will reveal the largest portion of the universe, which is only now barely perceived. In fact, the scientist will be able to see seven times farther into space than with groundbased telescopes, with a resolution ten times better, and observe objects which are fifty times fainter.

While in orbit, the observatory operations will be conducted by two major ground operations system elements, i.e., the Space Telescope Science Institute and the Space Telescope Operations Control Center. The Science Institute has been established to implement the Space Telescope Science Policy for the National Aeronautics and Space Administration, i.e., to solicit, evaluate, and select observational proposals submitted by competing observers, to coordinate correlative research, and to coordinate international participation. During the in-orbit operations, the Science Institute will generate candidate observing schedules and instructions, and reduce and analyze scientific data. The Operations Control Center is being established to perform mission scheduling, to monitor the status of the observatory, to process and analyze engineering data, and in the event of Space Telescope systems problems, to initiate corrective action.

MAJOR ACCOMPLISHMENTS

Major accomplishments since March 1981 include: Critical Design Reviews for the Optical Telescope Assembly, the Scientfic Instruments, the Support Systems Module major subcontractor components and the Solar Arrays; fabrication of hardware for the Optical Telescope Assembly, Support Systems Module, Solar Arrays, and Scientific Instruments; major development testing; developing and baselining Interface Control Documents; in-orbit maintenance development tests in the Marshall Space Flight Center (MSFC) Neutral Buoyancy Simulator (large water tank); award of the contract for the Space Telescope Science Institute, selection of the Director of the Institute and initiation of construction of the Science Institute; contract awards for major elements of the operations ground system; and, initiation of the maintenance and refurbishment effort. These activities are described briefly in the following paragraphs.

Critical Design Reviews (CDRs) - The CDRs scheduled for 1981 for the Optical Telescope Assembly electronics and minor structural elements were completed as planned. An additional design review for required changes in the Fine Guidance electronics was conducted in January 1982.

The CDR for the Wide Field/Planetary Camera was conducted in July 1981. This completes all of the Scientific Instrument CDRs.

The CDRs scheduled for 1981 for the Support Systems Module major subcontractor components were completed as planned.

The CDRs scheduled for the Solar Arrays for 1981 were conducted as planned for the European Space Agency (ESA) with participation by NASA. The major concern during the

reviews was associated with the welding of interconnects to the individual solar cells, and subsequent mission duration temperature cycle tests. An Audit Team, with membership from ESA and British Aerospace Engineering (BAe), was formed in November 1981 to review the welding procedures, documentation, welded solar cell samples and temperature cycle test results. The Audit Team completed its activities in late November 1981 and concluded that the main weld parameters were adequately controlled and produced repeatable weld quality. As a result, ESA decided to resume solar cell welding for the flight Solar Array blankets in December 1981.

The Project assessment of these reviews has also been completed and, even though some shortages were noted, no significant difficulties were found with the designs.

The Critical-Work Element Audit Reviews (C-WEARS) for the Support Systems Module and the Space Telescope were initiated in 1981. These C-WEARS are a series of subsystem and system reviews conducted incrementally over a period of months, and are scheduled for completion in March 1982. At the end of these reviews, CDRs for the Support Systems Module and the Space Telescope will be held at MSFC in March 1982.

Hardware Fabrication - Substantial progress was made during 1981 in flight hardware fabrication for various major elements of the Optical Telescope Assembly. The large, 96-inch, Primary Mirror, Figure 2, final polishing was completed by Perkin-Elmer at the Danbury, CT, facility in April 1981, and the measured figure quality is well within specifications that favorably contribute to a desired overall optical system wave front error of less than 1/20 of a wave. The Primary Mirror Coating Chamber, Figure 3, installation and verification was completed by Mill Lane of Boston, MA, at the Perkin-Elmer Wilton, CT, facility in October 1981. The coating of the Primary Mirror, Figure 4, was completed by Perkin-Elmer in December 1981, and preliminary analysis of witness samples indicates that the mirror reflectance exceeds specifications. The Primary Mirror will now be placed on a metrology mount, which reduces the distorting influences due to gravity, and the final figure quality, following coating, will be measured in late February 1982. The back-up Primary Mirror polishing was completed at Eastman Kodak, Rochester, NY, in August 1981. The back-up mirror will be shipped in late February 1982, to the Perkin-Elmer Danbury facility for storage, and will not be coated unless it is needed as a flight unit. The Secondary Mirror, Figure 5, final polishing and coating was completed by Perkin-Elmer in August 1981, and the figure quality and reflectance both exceed specifications. The flight Focal Plane Structure, Figure 6, fabrication was completed at Boeing Aerospace Corpora-

tion, Seattle, WA, and was delivered to Perkin-Elmer in June 1981. The Main Ring, Figure 7, fabrication was completed by the Excelco Corporation, Buffalo, NY, and was delivered to Perkin-Elmer in October 1981.

Good progress was made during 1981 in the fabrication of a number of major components for the Support Systems Module, for example, the Data Management Unit Engineering Model was completed by Lockheed Missiles and Space Company (LMSC), Sunnyvale, CA, in November 1981, and is now undergoing development testing. The Multiple Access Transponders were completed by Motorola, Scottsdale, AZ, and delivered to Lockheed in November 1981. The first flight computer was completed by Rockwell International, Anaheim, CA, and delivered to Lockheed in October 1981.

Good progress was also made during 1981 in the fabrication of major subsystems and components of the ESA provided Solar Array. As shown in Figure 8, the operations of the deployment mechanism, which will be used to roll-out the solar array blankets on-orbit, were successfully demonstrated on a water table. The fabrication of the flight blankets, including welding of solar cell interconnects and installing the cells on the flight blankets, and the associated functional testing, continued on schedule.

Substantial progress was also made during 1981 in the fabrication of a number of major components and subsystems for the Scientific Instruments and the Command and Data Handling Subsystem. A typical Scientific Instrument, the High Speed Photometer, is shown in Figure 9. The flight detectors for all five Scientific Instruments have been delivered and are available for assembly, the optical benches have been completed and delivered and, with minor exceptions, the flight optics have been completed and delivered. The Faint Object Spectrograph, flight digicon tubes and spares have been delivered and both flight units have been encapsulated. The red digicon tube has been assembled into the flight detector subsystem. The final assembly phase has started at the Martin Marietta Corporation, Denver, CO, and the optical bench is being mounted to the flight structure. The last three optical elements are being calibrated at the Johns Hopkins University, Baltimore, MD. The Faint Object Camera, being developed by the ESA, flight camera tubes have been received and the Flight Detector Subsystems are in the assembly stage. The final assembly and integration of the Proto-Flight Unit is nearing completion, and testing is planned to start in the first quarter of 1982. The High Speed Photometer final assembly and integration phase is nearing completion, and final systems testing and alignment of the Flight Optical Detector Subsystem to the flight structure is in progress at the University of Wisconsin, Madison, WI. The High Resolution Spectrograph, flight digicon tubes and spares

SPACE TELESCOPE PROJECT

STATUS
(CONT'D)

0 SCIENTIFIC INSTRUMENTS

- FABRICATION OF DETECTORS, OPTICS AND OPTICAL BENCHES COMPLETED
- MAJOR HARDWARE DEVELOPMENT TESTS STARTED
- SOFTWARE DEVELOPMENT/VERIFICATION TESTS STARTED
- FINAL ASSEMBLY STARTED
- REMOTE INTERFACE UNITS TO COMMAND AND DATA HANDLING SUBSYSTEM DELIVERED

FIGURE 12

FIGURE 13

SPACE TELESCOPE PROJECT

STATUS
(CONT'D)

- SCIENCE INSTITUTE
  - CONTRACT AWARDED TO THE ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY
  - LOCATED ON JOHNS HOPKINS UNIVERSITY HOMEWOOD CAMPUS
  - DR. RICCARDO GIACONNI NAMED AS DIRECTOR
  - CONSTRUCTION OF FACILITIES STARTED SEPTEMBER 1981
- MISSION OPERATIONS
  - CONTRACTS AWARDED
    - APPLICATIONS SOFTWARE SUPPORT - CSC, 11/81
    - SCIENCE OPERATIONS GROUND SYSTEMS - TRW, 12/81
    - MISSION OPERATIONS - LMSC, 2/82

FIGURE 14

SPACE TELESCOPE PROJECT

STATUS
(CONT'D)

- MAINTENANCE AND REFURBISHMENT
  - LIFE CYCLE PLAN COMPLETED
    - ORBITAL REPLACEMENT UNITS SELECTED
  - PROCUREMENT APPROACH DEVELOPED
  - LOGISTICS PLANNING EFFORT STARTED
  - SPACE SUPPORT EQUIPMENT REQUIREMENTS BASELINED
  - PRELIMINARY DESIGN PHASE STARTED AT MSFC

SPACE TELESCOPE PROJECT

PLANNED MAJOR ACTIVITIES - 1982

- Space Telescope and Support Systems Module CDRs
- Optical Telescope Assembly Integration
- Scientific Instruments Assembly and Functional Testing
- Operations Ground System and Science Institute Design Reviews
- Maintenance Refurbishment Contract Award

FIGURE 16

have been received and are being encapsulated and assembled into the flight detectors. Alignment of the fixed optics has been completed. All optical elements for the grating wheel have been fabricated, and assembly will be completed following calibration of the Echelle grating, which is in progress at the Goddard Space Flight Center (GSFC). The final assembly phase has begun at Ball Aerospace Division, Boulder, CO. The Wide Field/Planetary Camera, Charge Coupled Device (CCD), detectors have been received from Texas Instruments, Dallas, TX, and six devices have been selected as flight units. The other two flight units, plus spares, will be selected as the camera assembly process matures. A trial alignment of the camera has been completed and it verified that all optical elements are now ready to be aligned to the optical benches. All electrical parts and mechanisms are in the assembly and/or subsystems test phase at the Jet Propulsion Laboratory, Pasadena, CA. The Command and Data Handling Subsystem, Remote Interface Unit fabrication and testing was completed by IBM, Gaithersburg, MD, during 1981, and all flight units were delivered to the Scientific Instrument contractors for installation into the instruments. System performance testing, using a breadboard model control unit, of the Science Data Formatter is in process, and test results to date indicate that the design meets all requirements. Development and test of the flight software has started using a recently assembled software test and integration facility. The planning effort has begun for the Verification Acceptance Program, which will be utilized to demonstrate the Scientific Instruments system performance and compatibility with all software operational in the Command and Data Handling Subsystem.

Major Development Testing - The Optical Telescope Assembly Main Ring/Metering Truss Structure, Figure 10, integration and alignment verification was completed in December 1981, and the modal survey testing was completed in January 1982. The integration and alignment testing confirmed that the combined main ring/metering truss structure will be capable of maintaining the required spacing between the Primary and Secondary mirrors necessary to precisely focus the image of the observed object at the focal plane. The modal testing confirmed that the structural first mode bending frequency is well within acceptable limits.

To insure compliance with the very stringent line of sight pointing requirements of the Space Telescope, a number of critical tests of the Support Systems Module, Pointing Control System components were conducted during 1981, and will continue through the first half of 1982. The rate gyros, for example, which will be utilized for rate and attitude control, were subjected to a number of noise characterization tests at the Bendix Corporation,

Teterboro, NJ, and the Holloman Air Force Base, Alamagordo, NM. As the result of these tests, it was determined that the addition of a mechanical shroud around the gyro will significantly reduce the noise generated within the gyro, during its operation, and will greatly enhance its contribution toward meeting the desired line of sight stability specifications.

The major hardware development testing for the Scientific Instruments has been completed, with the exception of the vibration test of the Wide Field/Planetary Camera optical bench, which is scheduled for mid-1982. At this time, all Scientific Instruments are undergoing electrical testing to develop and verify the software to be utilized for operation of the instruments.

Interface Control Documents (ICDs) - The working groups established to produce detailed ICDs, made good progress during 1981 in the development and baselining of ICDs. At this time, the ICDs between the Support Systems Module and the Command and Data Handling Subsystem, the Tracking and Data Relay Satellite System and the Maintenance Mission Space Support Equipment have been baselined and are under control of Government Configuration Control Boards.

In-Orbit Maintenance Development Tests - In-orbit maintenance development tests were conducted in the MSFC Neutral Buoyancy Simulator, Figure 11, during 1981, to define and analyze Shuttle crew aids, e.g., tools, handholds, handrails, and foot constraints, required for in-orbit removal and replacement of Scientific Instruments, and contingency maintenance of Solar Arrays. Shuttle crew access for in-orbit replacement of critical subsystems and components located in the Support Systems Module equipment section was also demonstrated.

Science Institute - The Space Telescope Science Institute contract was awarded in April 1981 to the Association of Universities for Research in Astronomy (AURA). The site selected for the Science Institute will be on the Johns Hopkins University Homewood Campus in Baltimore, MD. An architect model of the Science Institute is shown in Figure 12. Dr. Riccardo Giacconi has been selected as the Director of the Institute. Since contract award, the Institute has concentrated its efforts in the areas of organizational set-up, Guide Star Selection System requirements definition and preliminary design, science data analysis software requirements definition, and coordination with ESA concerning their participation in the institute operations. Agreement has been reached on the number of ESA personnel to be located with the Institute, and a reporting schedule for these personnel.

Operations Ground System - The Science Operations Ground Systems contract was awarded to TRW, Redondo Beach, CA, in December 1981. TRW will concentrate its efforts toward developing the detailed requirements and implementing this hardware and software system which will be installed in the Space Telescope Science Institute and will be utilized for science operations and science data reduction. The Payload Operations Control Center, Applications Software Support contract was awarded to Computer Science Corporation, Silver Spring, MD, in November 1981. This contract will provide software for the Space Telescope Operations Control Center off-line operations support. The Mission Operations contract negotiations with Lockheed Missiles and Space Company, Sunnyvale, CA, were completed in December 1981, and the contract was awarded in February 1982. This contracted effort will define the Operations Control Center operations functions, and will perform mission operations while the Space Telescope is in orbit.

Maintenance and Refurbishment - The Maintenance Mission Development Plan was completed in June 1981. The selection of orbital replacement units, critical components and subsystems that can be replaced by the Shuttle crew on-orbit, was finalized and the Space Telescope life cycle plan was revised in July 1981, to be consistent with hardware reliability data from the maturing Space Telescope design. The life cycle plan was utilized as the basis for developing task requirements and supporting schedules. A procurement approach was developed to support the long range planning and preliminary procurement activities were started. A preliminary logistics planning effort was started in October 1981 to develop the logistics management program for transportation, preservation, packaging, marking, storage and testing of all flight and ground support hardware required for the maintenance and refurbishment activities. In a parallel effort, the maintenance mission space support equipment develpment plan was finalized, and a program requirements review was conducted in July 1981. All space support equipment requirements were baselined in November 1981, and are under configuration control, and the preliminary design phase has started.

PLANNED MAJOR ACTIVITIES

The next 12 months will be devoted to: the Space Telescope and Support Systems Module Critical Design Reviews; continued hardware fabrication; continued in-orbit maintenance development tests in the MSFC Neutral Buoyancy Simulator; design reviews and construction of the Science Institute; design reviews of the operations ground system; and maintenance and refurbishment design reviews and planning for procurement activities.

Critical Design Reviews (CDR's) - The CDR's for the Support Systems Module and the Space Telescope are being conducted during the month of March 1982 at MSFC. The Support Systems Module CDR will concentrate on the designs for the various major components and subsystems, as well as disciplines, such as Systems Engineering and Product Assurance. The Space Telescope CDR will concentrate on compliance with requirements interfaces and specifications by the various project elements, across the board.

Hardware Fabrication - The Scientific Instruments assembly phase and functional testing will be completed during 1982, and the environmental qualification and acceptance test programs will be started. The High Speed Photometer acceptance tests and calibration will be completed, and this instrument will be delivered to GSFC for the start of integration into the Verification Acceptance Program. The Faint Object Camera, Support Electronic Bay Assembly will be delivered by ESA to GSFC to facilitate the software conversion program that is scheduled for completion prior to delivery of the Proto-Flight Unit in 1983.

The Optical Telescope Assembly, Primary Mirror figure quality testing was completed in late February 1982, and the integration of major elements, e.g., main ring, metering truss structure, focal plane assembly, etc., for the Optical Telescope Assembly will continue.

The Support Systems Module manufacturing phase will continue during this period. Testing and assessment of the critical components of the Pointing Control Systems will also continue, and modification of the rate gyros to include the mechanical shroud for noise reduction will be started for all flight units. The development testing of the Engineering Model Data Management Unit will be completed and fabrication of the flight unit will be started.

In-Orbit Maintenance Development Tests - In-orbit maintenance development tests in the MSFC Neutral Buoyancy Simulator will be conducted during 1982, to verify concepts for the maintenance mission space support equipment in support of the preliminary design activities.

Science Institute - The Science Institute major activities for 1982 will include the Guide Star Selection System Preliminary and Critical Design Reviews, Science Data Analysis Software preliminary requirements reviews and design reviews, and completion of the major construction of the facility exterior.

Operations Ground System - The preliminary requirements review and design reviews for the Science Operations Ground System will be conducted during 1982, and the hardware will be determined.

Maintenance and Refurbishment - The planning for maintenance and refurbishment procurement activities will be continued during 1982. The Request for Proposals for the maintenance and refurbishment contract for the first orbital maintenance mission will be released in April 1982, with contractor selection planned for December 1982. This contract activity will include procurement of the orbital replacement units for this mission. A system review for the Space Support Equipment is scheduled for July 1982 to assure compatibility with the various project elements as the preliminary design matures.

In summary, the Space Telescope Project is making substantial progress in satisfying program requirements. Design and development activities are nearing completion in all major areas, and significant progress is being made in hardware fabrication of the Spacecraft Systems and Scientific Instruments. The Project is on schedule for launch in the first half of 1985, and is within estimated costs.

[Figures 1-12 of Dr. Speer's prepared statement follow:]

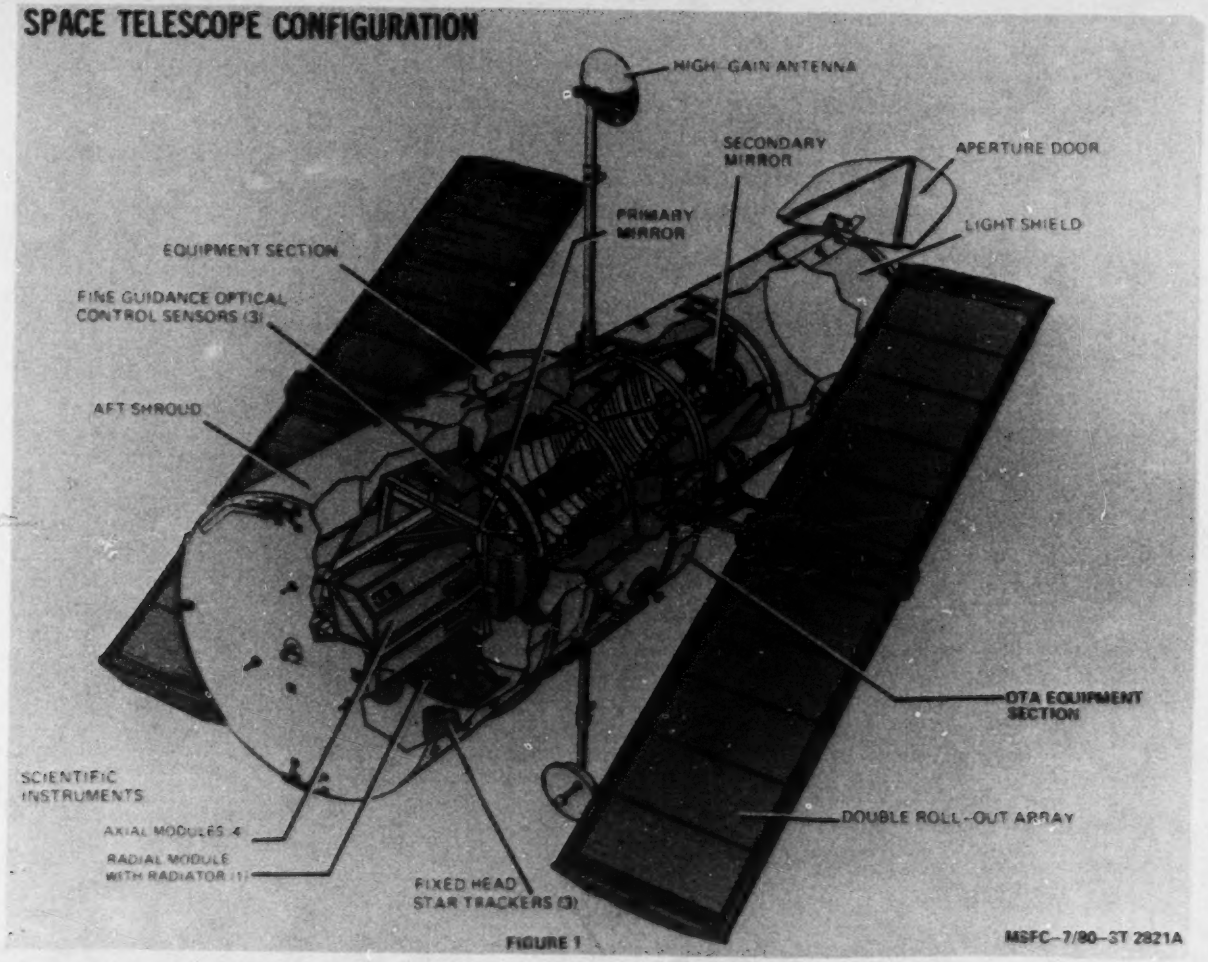

SPACE TELESCOPE CONFIGURATION
HIGH GAIN ANTENNA
SECONDARY MIRROR
APERTURE DOOR
PRIMARY MIRROR
LIGHT SHIELD
EQUIPMENT SECTION
FINE GUIDANCE OPTICAL CONTROL SENSORS (3)
AFT SHROUD
OTA EQUIPMENT SECTION
SCIENTIFIC INSTRUMENTS
DOUBLE ROLL-OUT ARRAY
AXIAL MODULES 4
RADIAL MODULE WITH RADIATOR (1)
FIXED HEAD STAR TRACKERS (3)
FIGURE 1
MSFC-7/80-ST 2821A

FIGURE 2

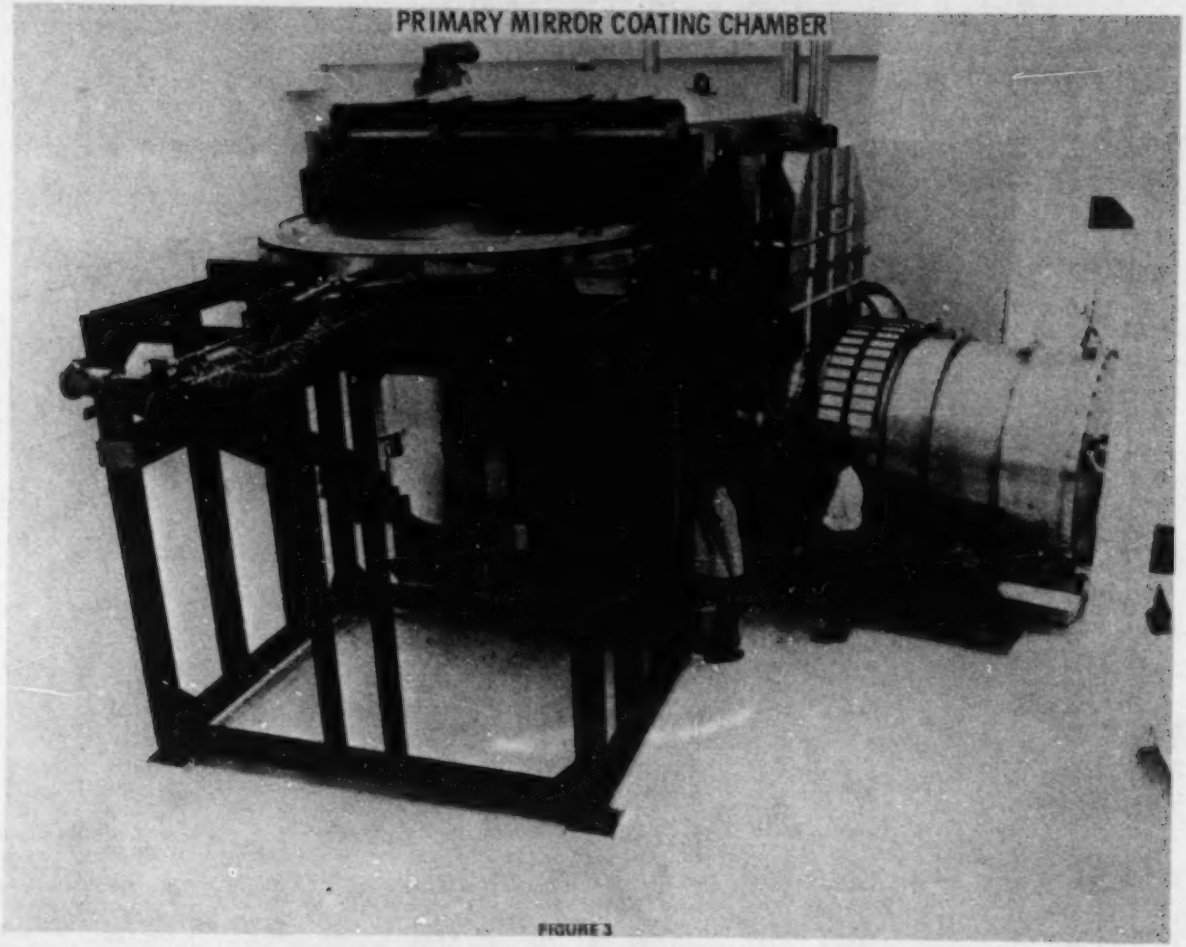
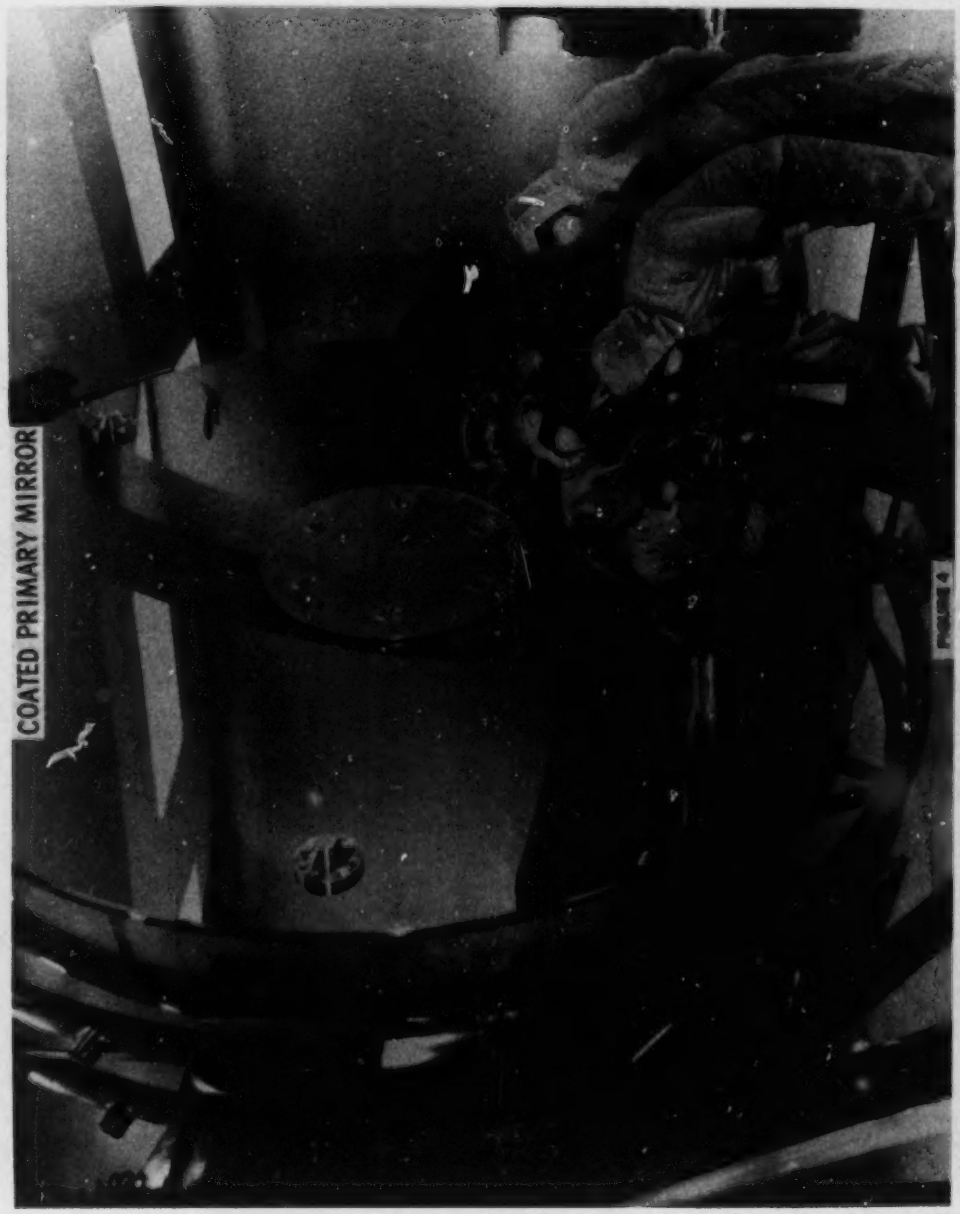


FIGURE 3


COATED PRIMARY MIRROR

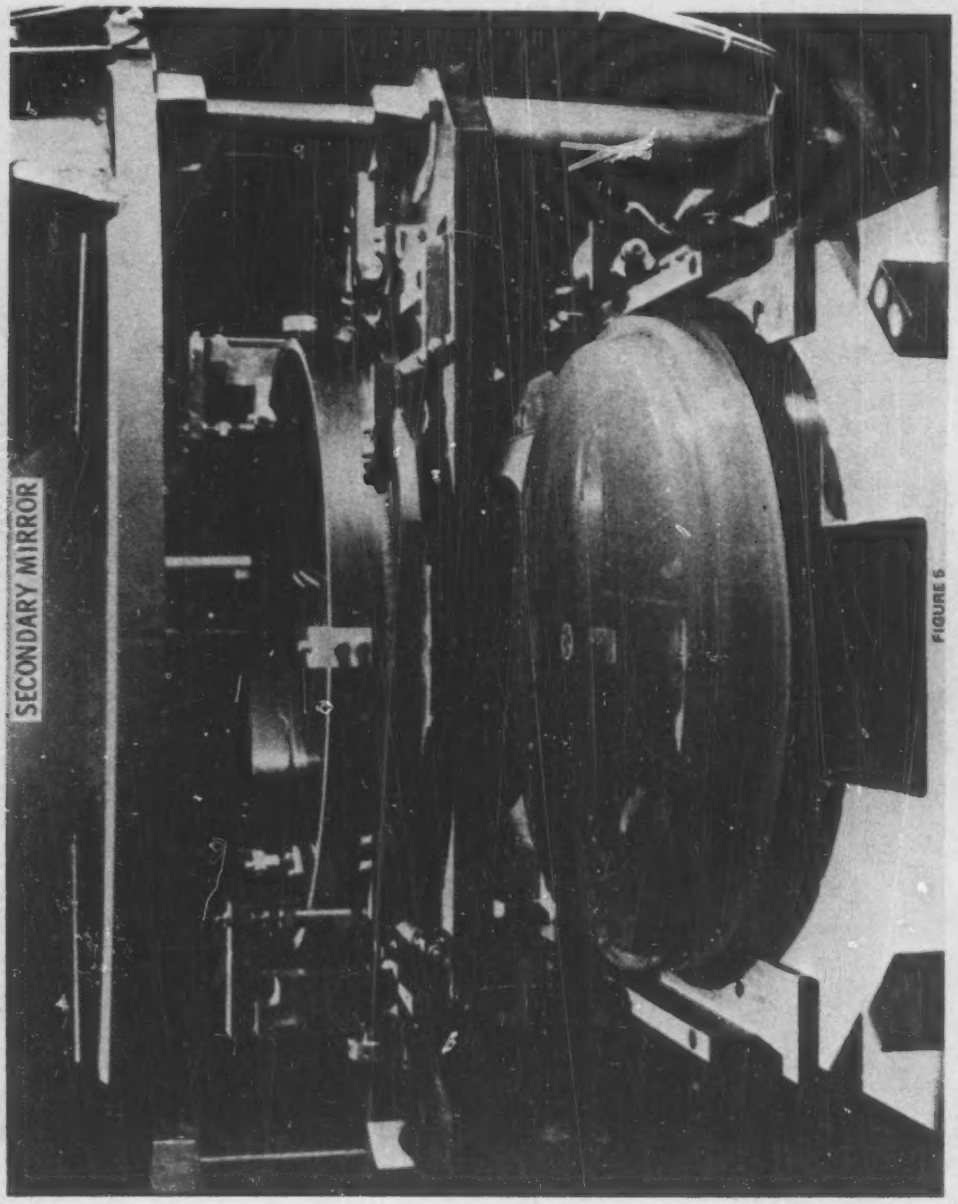


FIGURE 5

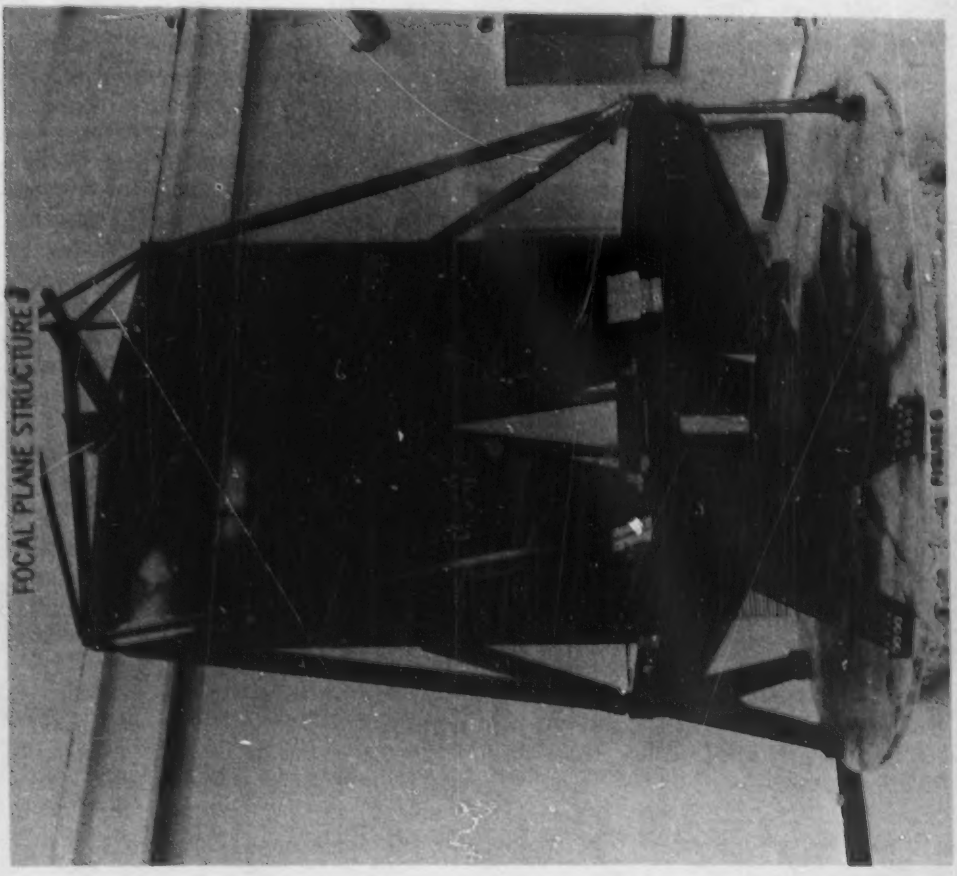

FOCAL PLANE STRUCTURE

FIGURE 7

FIGURE 8

FIGURE 9

MAIN RING AND METERING TRUSS STRUCTURE

FIGURE 10

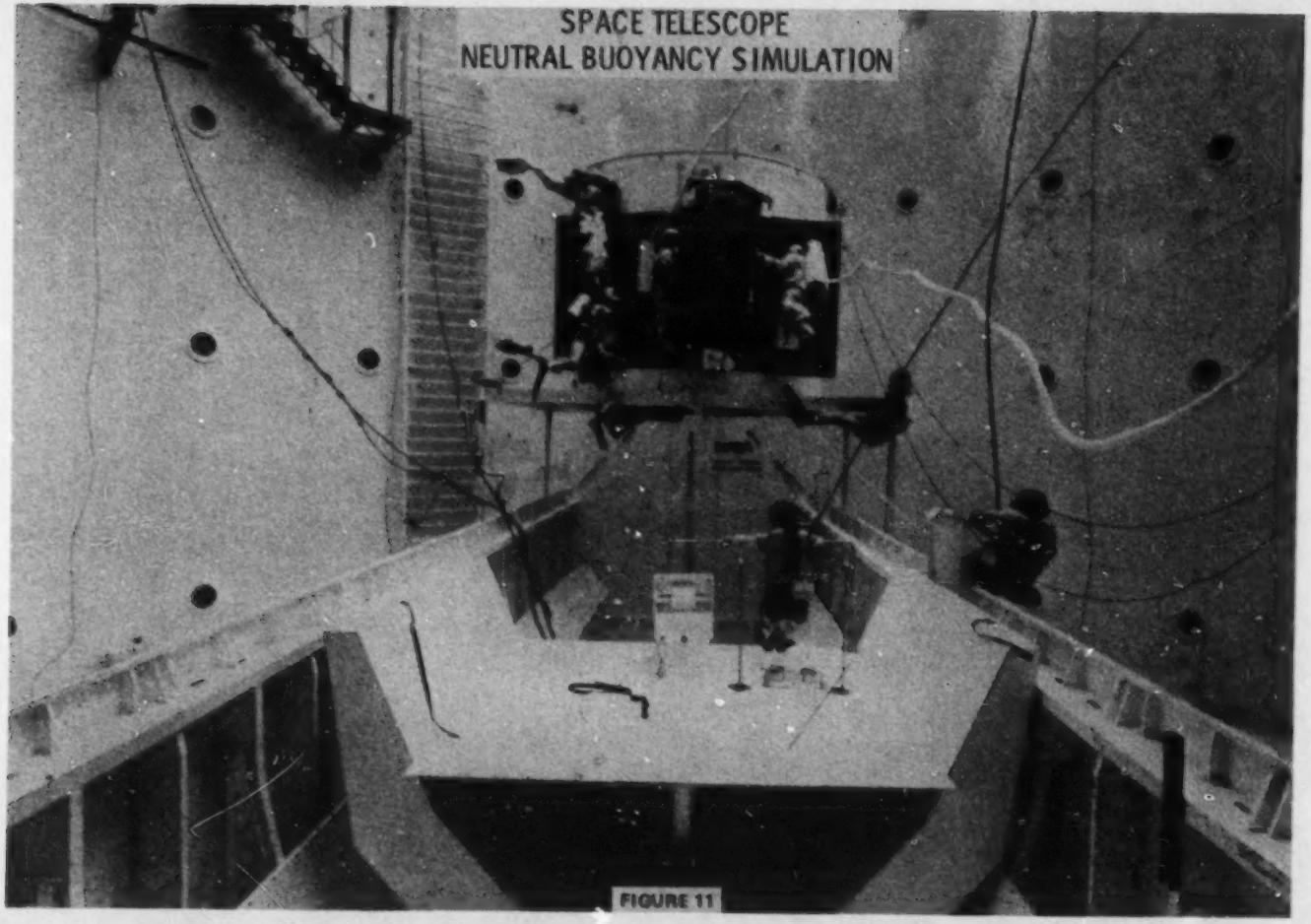


FIGURE 11

Mr. MARSHALL. Mr. Chairman and Chairman Fuqua, today we will discuss some of the advanced programs that we are working on here at the Marshall Space Flight Center. At the beginning of the program, Dr. Lucas covered some of the approved programs as listed on figure 1. I will be addressing those programs which are in the feasibility and definition phases, as listed on figure 2. I will be discussing the potential Space Platform in detail to define the concept and what it can accomplish. We discussed the Tethered Satellite last year, and I will not cover it in detail this year. The Tethered Satellite is a very exciting program. A ball of approximately 1½ meters in diameter is suspended from the Shuttle by a tether into the atmosphere to take measurements. These measurements are difficult because of the drag the satellite is subjected to from the atmosphere. The Tethered Satellite is a joint program with the Italians and we hope to progress from the present advanced study to a possible hardware start in fiscal year 1984.

Another program which we are working on at the Center that I will not be discussing in depth with you today is the gravity probe-B. The objective of this program is to test Einstein's General Theory of Relativity. This program is in an in-house phase B design and definition phase. We could initiate a new start in about one year.

Because of the crowding of the segment of the geostationary orbit above the equator where we are locating our communications satellites, we are studying new ways of utilizing those positions and we believe that in the future a Geostationary Platform will be needed. This represents a new technology and utilizes advanced electronics. The Deployable Antenna supports the Geostationary Platform. Today when we launch satellites with antennas on them, they fold out much like an umbrella. The state of the technology at present is limited to antennas about 5 meters in diameter. In the future, we will utilize antennas on the order of 100 meters in diameter—the size of a football field. These antennas will have multiple feeds and be constructed of light-weight materials. We have some experiments underway at the Center to demonstrate these new requirements. These, and other large space structures, are being studied in detail as we develop the capability to construct and use these large structures in space.

We have completed a number of studies on systems definition and requirements for the type of Orbital Transfer Vehicle we would need to accomplish future NASA requirements.

I will not discuss the Solar Terrestrial Observatory today. The concept of the experiment is to simultaneously record data of the Sun's activities, atmospheric disturbances and ground conditions. In the past, we have recorded event data independently and have not been able to correlate potential cause and effect results.

The Pinhole Occulter is a Spacelab experiment which will provide various data on the characteristics of the Sun. The facility uses thousands of pinhole optics on the end of a long boom to image the Sun's X-ray emissions. The experiment also contains a mask which occults the bright solar disk so that the faint corona can be studied, in much the same manner as the corona can be studied during an eclipse.

Key to our discussion of permanent presence in space is the Space Platform. The Space Platform is a system in orbit to provide power, communications, thermal control, and stabilization. Payloads would be attached to the Space Platform as shown on the model before you. These are Spacelab payloads which are designed to fly on the Shuttle and Spacelab. The Space Platform could accommodate a manned module. I will explain to you how the system integrates itself together into a unique approach that we refer to as Evolutionary. Shown in figure 3 is a program schedule that could allow initiation of a Space Platform development activities beginning in fiscal year 1984 and establishing a permanent presence in space by 1987, and expanding in capability through the 1990's. Geostationary orbit [GEO] manned access, as shown on this chart, does not mean a permanently manned geostationary facility, but the access of man to and from the geostationary orbit. This access would require additional systems, which I will not discuss. The key purpose of the geostationary activity is that it defines technology needed to meet future program requirements.

From the evolutionary approach I will discuss the Space Platform, the Space Station and the associated technology activities that would allow us to grow to the capability that we perceive will be needed in the 1990's.

Figure 4 is a pictorial of the evolutionary sequence moving from an unmanned platform, which could accommodate various science missions and commercial materials processing experiments, in the late 1980's to a possible manned platform in the early 1990's.

The Shuttle is the cornerstone of our future operations in space. It offers the opportunity to make frequent visits to space in a very unique way. We can bring things back. Of course, the primary purpose of the Shuttle is transportation from ground to low earth orbit [LEO] and back. Additionally, Spacelab provides an expanded volume to live and work in orbit. A study of the space transportation system suggests the need for more time and accommodations for experiments than the Shuttle provides.

Chairman FLIPPO. Bob, in the past we have spent our money on the Shuttle and now we have criticism from some sectors that say we haven't spent enough money defining what we are going to do with the Shuttle once it's operational. Do you believe the advanced programs funds are adequate to seriously look at what we should do with the Shuttle?

Mr. MARSHALL. I think we are at a point where additional funding in this area would give us a much clearer understanding of how to better utilize the Shuttle. We have experienced a substantial reduction in the buying power of our funds in the advanced planning area for the last 5 to 7 years. We need to look at the additional capability that the Shuttle makes available to us.

The Shuttle gives us the capability to perform experiments in a 7-day mode. However, a number of experiments would benefit from a longer time in orbit. This particular one, on the model, is an infrared telescope which could be transferred from the payload bay of the Shuttle and attached directly to a power system by remote manipulator system [RMS]. The telescope could then be left on orbit for 3 to 6 months rather than 7 days. There is a significant

increase in the science to be gathered. Figure 5 is an artist's concept of the model on the table before you.

We have completed two phase B definition studies of the Space Platform, as indicated on figure 6, and these have been extended to enable us to look at potential hardware development. For example, here at the Marshall Space Flight Center, we have recently completed a berthing test of the potential mechanism that would be used to attach the Shuttle to the Space Platform. We are continuing these types of activities and we believe we will be ready to initiate a new program in 1984. The Space Platform has support systems like the Space Telescope which is being developed at MSFC; that is the platform provides stabilization, communications, thermal, and power to experiments when attached.

When we started working with the Space Platform concept, we made contacts with the user community—the people we would be servicing—to make sure that the program was designed in such a way that they could use it and support it. Along the way, we have been very careful to keep ourselves in touch with the potential users some of which are shown on figure 7, and I believe we have arrived at a point where we have excellent support from the science community. In fact, we have a number of ongoing activities with several science committees to design experiments for the Space Platform.

Additionally, as Dr. Lucas mentioned earier, materials processing may be the next endeavor to industrialize and commercialize space. In figure 8, the top arrow, identifies our normal transportation system and the kinds of technologies that have been spun off. The most visible of our commercial endeavors is space communications. Additionally, we have developed weather satellites. I believe materials processing can be the next area of space commercialization. One of the key things to observe on this chart is that the Government has sponsored, or funded, the initial thrust. However, when the private sector perceived the opportunity, they took over and the Government phased out. I believe we are approaching this point in materials processing. There are some present agreements between the Government and the industry which are beginning to emphasize industrialization. The Shuttle is a key element in this effort as it is the transportation system for research and technology development for potential programs or products.

As shown in figure 9, the initial part of the program utilizes the mid-deck, pallet, and Spacelab. As we move through the program, beginning with research and proof of concept, then transitioning into a commercial program, I believe the industrial community and the commercial market will find the program. There are two activities in industrialization that have potential for gain by space exploration. As Dr. Lucas said this morning there is the application to the ground systems of the improvements learned in space. Then, there is the entirely new opportunity for industrialization in space. This program will assist in both areas.

When we reach a status, as we have in some of the programs today, that more power than the Shuttle can provide is required, the Space Platform is the answer to that need. The Space Platform is a power source and a facility to accommodate the experiments on orbit. The Shuttle system then would become the transportation

system—or "truckline"—for servicing the "factory." I believe that in the future the commercial marketplace will buy its own Space Platform and either use the entire system or rent out space to other users.

This evolutionary approach, as I mentioned earlier, allows us to move from the unmanned to manned Space Platforms by the addition of a habitability module. Figure 10 illustrates that transition. Relying on our past experiences with the Skylab program, we have studied the Spacelab to determine the modifications necessary to leave it in orbit as a manned habitat. We have identified the Spacelab systems listed on figure 10 as usable to support the mission. Specific Shuttle systems have been selected to be added to the Spacelab to make it autonomous. With the addition of the systems support to Spacelab, a logistics module, and docking to the Space Platform, we have established a concept for a manned facility in low-Earth orbit.

As I mentioned earlier in the discussion of figure 3, there is technology work required to define a Space Station for the year 2000. There are three major technology areas to be studied [fig. 11]. Earlier I discussed the potential need for learning about cryogenic fluid storage, for a space-based Orbital Transfer Vehicle. Also, satellite servicing of spacecraft on orbit can be very beneficial. Servicing could be replacement or repair of systems or replenishment of expendables. Finally, large space structures in space are a need in the future. As Dr. Speer told you when he discussed the Space Telescope, the assembly of large optics on the ground is not simple matter. Assembly of optics in orbit must be understood and techniques developed. These are some of the technology areas we are going to be working to define space station requirements for design. There are two approaches for a space station. Figure 12 defines a colony in space. There would be living quarters for the astronauts separate from the "factory." With the habitat separate from the factory, the astronauts could go home at night if there is a mishap in the factory and then determine what action is required to restore it. A small spacecraft, a Teleoperator Maneuvering System [TMS], may be required as a scooter or tug to transport man or materials between home and work station. The multiple Space Platforms, in this concept, would fly in formation above or below, in front or behind each other in orbit and be accessible via the TMS. Finally, as shown on figure 13, we think the Space Platform could fit within the present budget. It is a complementary program to the Shuttle. The design is compatible with multiple future use. The design is compatible with multiple future use. The design and costs have been well defined. The Space Platform would be a tool which would be optimized for various functions and simplified to remain low cost and take full advantage of emerging technology.

That completes my discussion of the Space Platform, Space Station and potential commercialization of materials processing in space.

The first Advanced Transportation System I will address provides flexibility to the Shuttle delivery system. I touched on one of its uses briefly when I discussed the formation flying concept. It is a Teleoperator Maneuvering System [TMS] and could move large

or small payloads from the Shuttle to another orbit position and return to the Shuttle.

Figure 14 is an illustration of the TMS and it also shows the small amount of space that the TMS takes up in the Shuttle bay. There are going to be multiple payloads in the bay—perhaps as many as six or seven individual payloads. Some of these payloads may require delivery to an orbit different from the Shuttle.

Chairman FLIPPO. Did you address NASA missions only or did you work with the military to look at the needs as well?

Mr. MARSHALL. Yes, sir, Mr. Chairman, we have.

Chairman FLIPPO. Thank you.

Mr. MARSHALL. The TMS activity [fig. 15] is in a phase A or definition study. We are prepared to initiate phase B. I believe the phase C/D, design and development, could be initiated in fiscal year 1984 and is needed. Figure 16 shows the various applications of the TMS. As I mentioned, when payloads are delivered to orbit on the Shuttle, the capability is needed to move the payloads to other orbits. This is a simple use of the system. Another capability that is needed is to be able to retrieve a spacecraft and bring it back to the Shuttle for servicing. There may, in fact, be an instance where a spacecraft is out of control. We would not want to risk approaching it with the Shuttle. We would want to stabilize it and assure it was safe before it was move to the Shuttle. The TMS would be designed with these capabilities. Another performance requirement for some payloads is to change orbit planes. Orbit altitude and plane changes are very difficult in terms of the propulsion that is required. The TMS could accommodate plane changes and return to the Shuttle or Space Station. The TMS could also be used as a propulsion module to adjust the altitide of Space Platforms or a Space Station.

Since we developed the technology for the Shuttle, we have assessed the application of this technology for new transportation systems. There are two capabilities to be addressed. The first considers delivering large cargo to low-Earth orbit—both in terms of size and weight. The second requirement is matching the Shuttle performance with an unmanned vehicle. We are assessing the future needs for this capability. Some of the concepts being assessed are illustrated on figure 17.

The first Shuttle Derived Launch Vehicle concept I will discuss is the Aft Cargo Carrier. As you can see in the vehicle illustration figure 18, there is a rather large volume under the external tank and between the two SRB's. This volume could be encapsulated to carry bulky items to orbit, thereby increasing the total volume to orbit. It would add about 13,000 cubic feet to the existing 10,000 cubic feet in the Orbiter cargo bay as shown in figure 19. There are some concerns to be considered with the use of this volume. The volume is in avery noisy region, but we believe there are technologies today that will allow us to reduce that environment to an acceptable level.

Figures 20 and 21 show the two solid rocket booster concepts. Figure 20 is a single segment SRB atop a four-segment SRB. It could be used either with or without a cryogenic upper stage, depending on the performance requirement, and launched directly from the launch pad that the Shuttle uses. For greater capability,

SRB's could be positioned parallel to a third SRB in place of the external tank. The upper stage and payload would then be mounted atop the center SRB. The SRB's would burn in parallel for the parallel confiruration and in series for the single stack. When the first stage SRB's were burned out, they would be recovered and returned for reuse just as they are with the Shuttle. Upper stages would probably not be retrievable. The capabilities of thest two SRB concepts are shown on the bottom of figure 23.

The reason we considered the SRB–X as a candidate for a mixed fleet is shown on figure 22. There are potential cost advantages by volume buying. We could use existing launch facilities. We could interchange specific payloads with a minumum leadtime. If there were an emergency requirement to increase SRB–X launches, Shuttle SRB's could be diverted to the unmanned vehicles.'

There are indications of future requirements to launch payloads in the range of 150,000 pounds in a single delivery. We have addressed how this might be done with today's Shuttle technology. This size of payload will be encountered infrequently. There are two basic approaches to address this problem. The first approach, called the In-Line concept, shown in figures 24 and 25, uses three-segment SRB's, a shortened external tank and one or two SSME's as the payload might dictate. With two SSME's the vehicle can deliver about 150,000 pounds to low-Earth orbit. The tradeoff to invest in a recoverable SSME design or accept the SSME loss will be accomplished. Another approach is the "Side Mount" concept shown in figures 26 and 27. In this approach, the arrangement of SRB and external tank is the same as for the Shuttle. However, in lieu of the Oribter, we have used the aft engine compartment and systems and replaced the Orbiter with a cargo cannister of varying diameter.

The last item I will discuss is the Advanced X-Ray Astrophysics Facility, shown in figures 28 and 29. You asked Dr. Lucas about the data from the HEAO program and whether that data is still being evaluated. HEAO–2 observed thousands of celestial objects and demonstrated for the first time the importance of focusing X-ray astronomy. The results of HEAO involved hundreds of scientists and created great excitment throughout the astrophysics community. This mission made a great advancement in X-ray astronomy.

The HEAO results have raised additional scientific questions and also demonstrated the requirement to probe deeper with a more powerful system. Some of these basic questions that will be addressed involve the future of the universe—whether it will expand forever or will eventually collapse. Other questions deal with new X-ray sources in space and the physical processes and conditions within them. The HEAO mission could not answer all these questions but it did demonstrate that the X-ray astronomy of the future can help us answer them.

The AXAF would allow us to examine celestial objects in much more detail by providing a finer angular resolution. If you observe a black hole candidate, for example, you will be better able to determine if it is a black hole or some other compact object.

A hundred-fold increase in sensitivity over HEAO–2 will allow us to see objects never observed before and we will be able to see them in much more detail and thus be able to better understand them.

Certainly we would add to this the longer life AXAF will have over HEAO. This would allow X-ray astronomers to follow up on discoveries for the first time.

During the past year, we have been working the technology area along several fronts. We are learning how well we can polish a mirror and what the X-ray scattering characteristics of different surfaces are. We have reached the point where we are ready to go out with two contracts to obtain small engineering test models of the optical system to verify the technology for the larger AXAF mirrors. We will be moving very shortly into our phase B studies and we could be ready as early as fiscal year 1985 for a new initiative of this program.

This completes my discussion of the advanced systems.

Dr. LUCAS. Mr. Chairman, that completes the oral testimony. We are available to receive any questions you might have.

Chairman FLIPPO. Thank you very much. It was a good program and I appreciate very much the testimony and the hospitality that you have shown us today. That concludes the record.

[Figures 1–29 of Mr. Marshall's oral presentation, and the prepared statements of Mr. Thomas, Mr. Downey, Mr. Zoller, and Mr. Powell follow:]

FIGURE 12

MSFC PROGRAM/PROJECT ACTIVITY

603-80 2/10/82

APPROVED FOR IMPLEMENTATION	ASSIGNED FOR DEFINITION	PROPOSED FOR FUTURE
● SPACE SHUTTLE – MAIN ENGINE – EXTERNAL TANK – SOLID ROCKET BOOSTER – SYSTEMS ANALYSIS, TEST & INTEGRATION		● SOLID ROCKET BOOSTER UNMANNED LAUNCH VEHICLE (SRB–X) ● SHUTTLE DERIVED LAUNCH VEHICLES
● STS OPERATIONS	● SPACE PLATFORM	● SCIENCE AND APPLICATIONS SPACE PLATFORMS ● GEOSTATIONARY PLATFORM
● INERTIAL UPPER STAGE		● ORBITAL TRANSFER VEHICLE ● TELEOPERATOR MANEUVERING SYSTEM
● SPACELAB	● TETHERED SATELLITE SYSTEM	
● SPACELAB P/L MISSION MGMT		● DEPLOYABLE ANTENNA FLIGHT EXPERIMENT
● MATERIALS PROCESSING – EXPERIMENT DEVELOPMENT – PRECURSOR EXPERIMENTS – SPACE SHUTTLE PAYLOADS		● LARGE SPACE STRUCTURES ENGINEERING
● HIGH ENERGY ASTRONOMY OBSERVATORIES	● ADVANCED X–RAY ASTROPHYSICS FACILITY (AXAF)	● SOLAR TERRESTRIAL OBSERVATORY ● PIN HOLE OCCULTER
● SPACE TELESCOPE		
● FLIGHT EXPERIMENTS	● GRAVITY PROBE B(GP–B)	
● SUPPORTING RESEARCH AND TECHNOLOGY		

FIGURE 1

ADVANCED SYSTEMS

- MANNED PRESENCE IN SPACE
  - SPACE PLATFORM
  - SPACE STATION
  - MATERIALS PROCESSING IN SPACE
- ADVANCED TRANSPORTATION SYSTEM
  - TELEOPERATOR MANEUVERING SYSTEM
  - SHUTTLE DERIVED LAUNCH VEHICLES
- SCIENCE AND APPLICATIONS PAYLOADS
  - ADVANCED X-RAY ASTROPHYSICS FACILITY

FIGURE 2

3974–81

EVOLUTIONARY PROGRAM

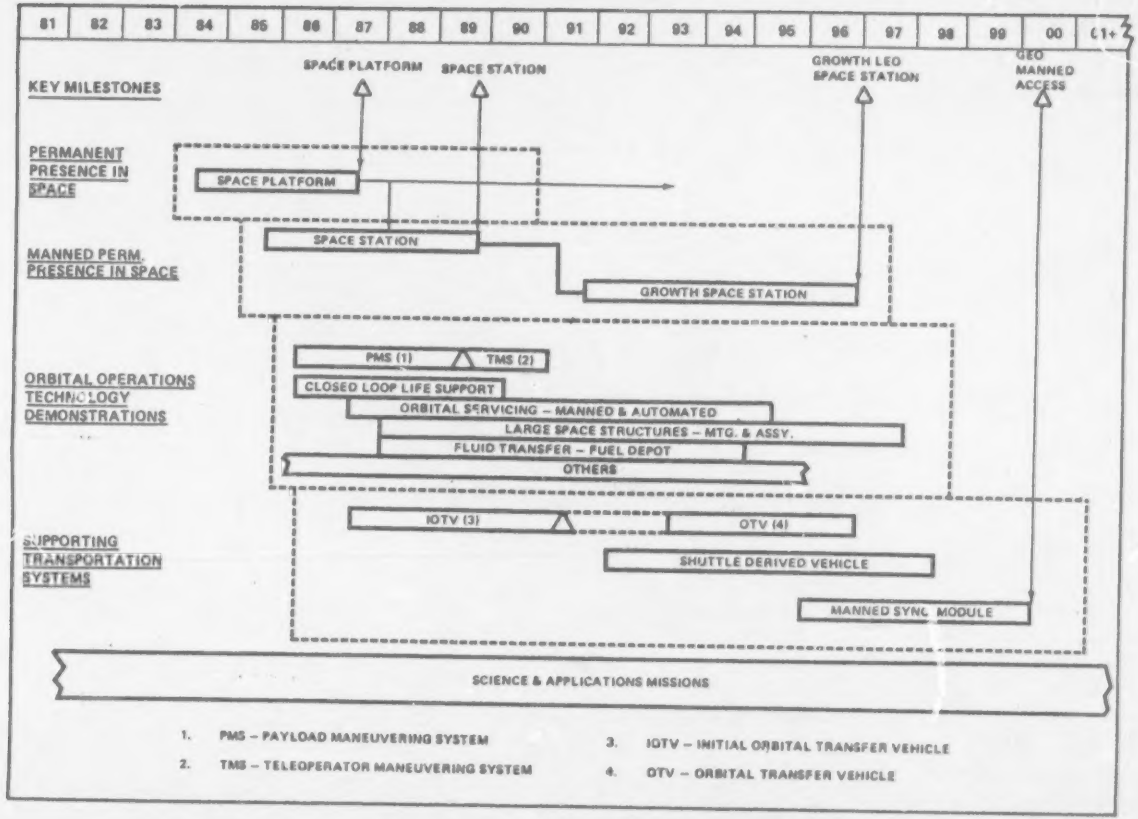


FIGURE 3

PLATFORM UTILIZATION

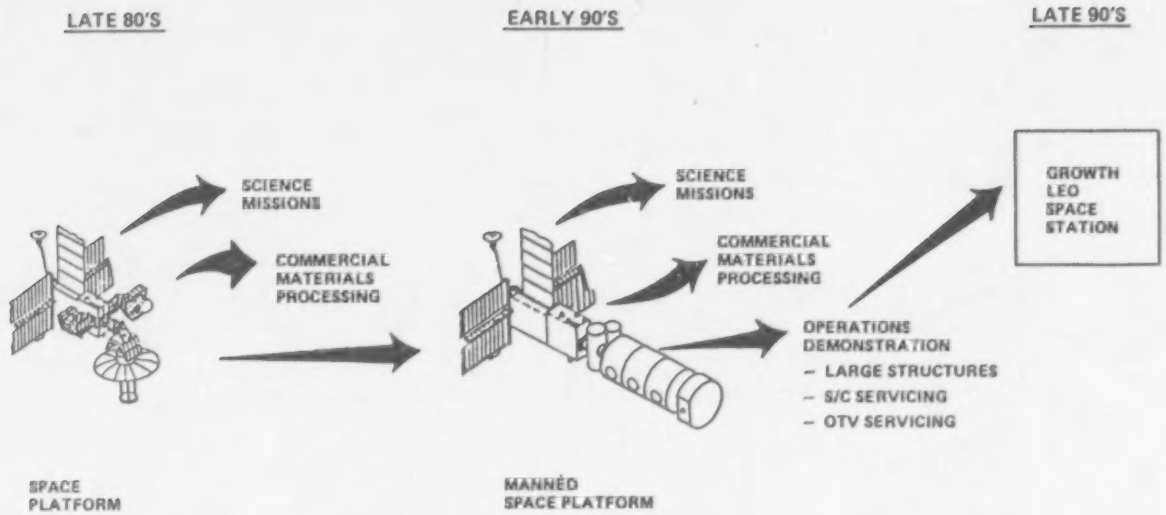


FIGURE 4

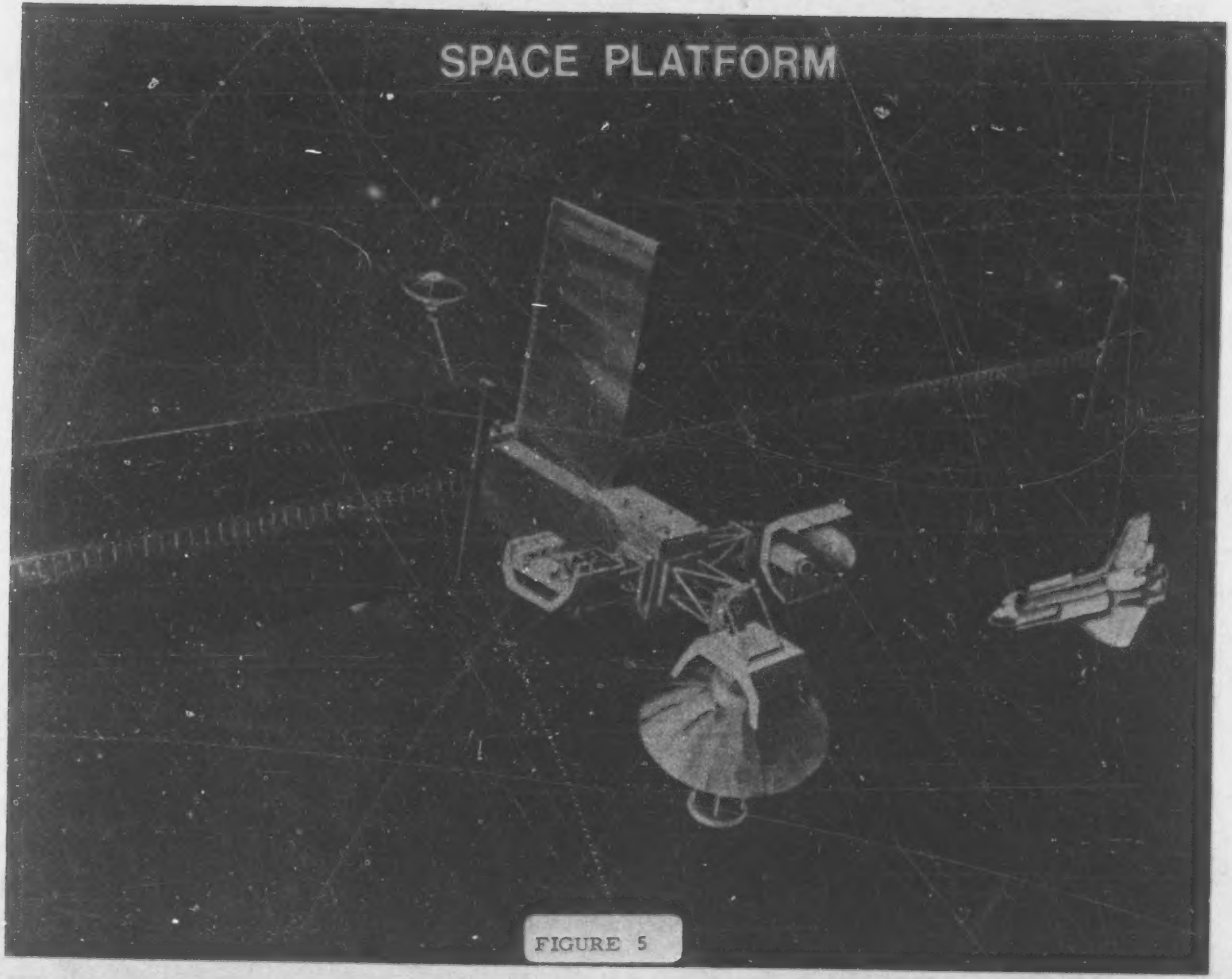


FIGURE 5

659-81

SPACE PLATFORM

- CURRENT SPACE TRANSPORTATION SYSTEM (STS) PROVIDES
  - FREQUENT FLIGHT OPPORTUNITIES
  - RETURN OF PAYLOADS TO GROUND
  - ORBITAL EXPERIMENTAL FACILITY (SPACELAB)
- EXPANSION OF SHUTTLE AND SPACELAB UTILITY VIA SPACE PLATFORM
  - LONGER ORBITAL STAY-TIME
  - INCREASED POWER/THERMAL FOR USERS
  - MAINTAIN EFFICIENT UTILIZATION OF THE STS
- DUAL PHASE B STUDIES COMPLETED
- FABRICATED AND TESTED ENGINEERING MODELS OF COMPONENTS AND MECHANISMS

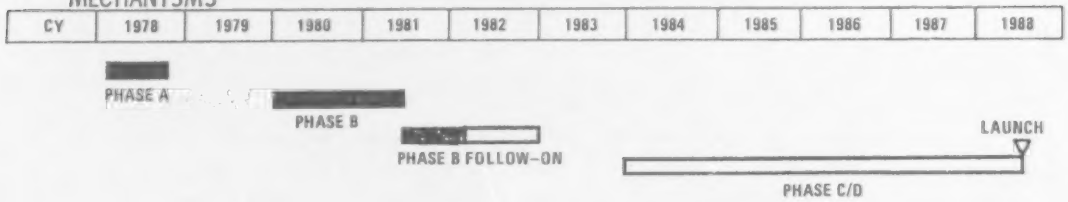


FIGURE 6

COMMITTEES WHICH HAVE PARTICIPATED IN PLATFORM ACTIVITIES

NATIONAL ACADEMY OF SCIENCES

- SPACE SCIENCE BOARD (BRIEFING GIVEN IN MAY 1979, FEBRUARY 1981)
- COMMITTEE ON SPACE PHYSICS (1979)*
- COMMITTEE ON SPACE ASTRONOMY AND ASTROPHYSICS (JULY 1979, FEB. 1980, APRIL 1981)*
- COMMITTEE ON SOLAR–TERRESTRIAL RESEARCH (1979)*
- ASTRONOMY SURVEY COMMITTEE (JULY 1980)*

NATIONAL ACADEMY OF ENGINEERS

- COMMITTEE ON TECHNOLOGY OF LARGE SPACE SYSTEMS (JUNE 1979)

NASA ADVISORY COMMITTEES

- NASA ADVISORY COUNCIL (MAY 1979)
- SPACE SCIENCE ADVISORY COMMITTEE (3 BRIEFINGS IN 1979, 1 IN 1980)*
- SPACE SCIENCE SUBCOMMITTEE ON SPACE PLATFORMS (2 BRIEFINGS IN APRIL 1981, 1 IN NOVEMBER 1981)

NASA MANAGEMENT OPERATIONS WORKING GROUPS

- ATMOSPHERIC AND SPACE PHYSICS (1979, 1981)*
- SOLAR PHYSICS (1979, 1981)*
- HIGH ENERGY PHYSICS (1979, 1980, 1981)*
- ASTRONOMY (1980)*

SCIENCE STUDY GROUPS

- SOLAR TERRESTRIAL OBSERVATORY SCIENCE (NOVEMBER 1979, JULY 1980)*
- ADVANCED SOLAR OBSERVATORY (JUNE 1981)

*PROVIDED REPRESENTATIVE (S) FOR PHASE A USER REVIEW GROUP

NASA HQ EM82-400 (1)
12-29-81

FIGURE 7

U. S. SPACE PROGRAM

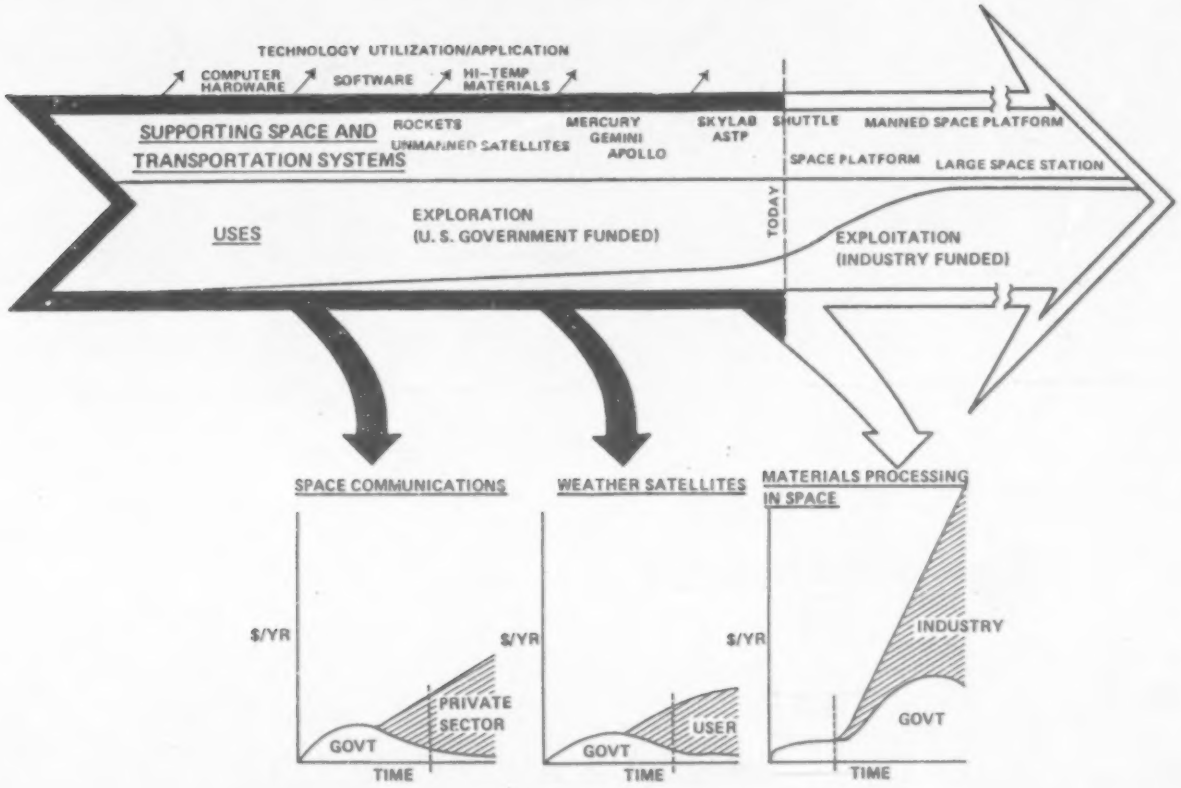


FIGURE 8

SPACE INDUSTRIALIZATION EVOLUTION

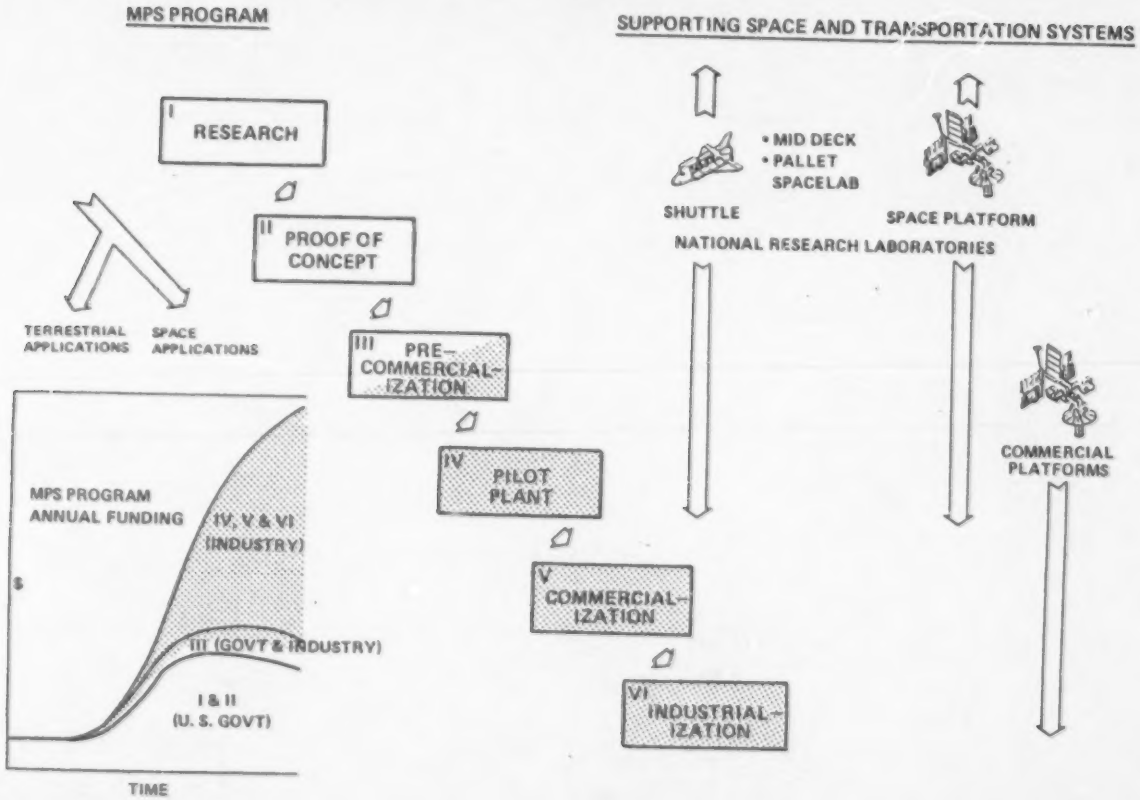


FIGURE 9

TRANSITION TO MANNED SPACE PLATFORM

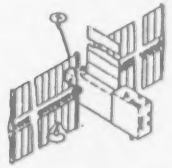
SPACELAB

- PRIMARY & SECONDARY STRUCTURE
- INSULATION
- THERMAL CONTROL
- ATMOSPHERE REVITALIZATION
- CONTROLS & DISPLAYS
- DATA MANAGEMENT
- POWER DISTRIBUTION
- EXPERIMENT RACKS & INTERFACES

SHUTTLE EQUIPMENT

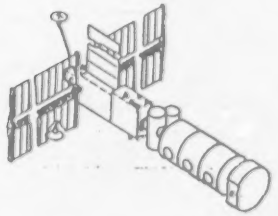
- FOOD MANAGEMENT
- WASTE MANAGEMENT
- SLEEP RESTRAINTS
- EVA SUITS
- EVA AIRLOCK & SUBSYSTEM
- EXERCISE EQUIPMENT (IMPROVED)
- SHOWER (SKYLAB)

SPACE PLATFORM



- ELECTRICAL POWER
- COMMUNICATIONS/DATA
- ATTITUDE CONTROL
- HEAT REJECTION
- REBOOST PROPULSION
- DATA MANAGEMENT

MANNED SPACE PLATFORM



SHUTTLE LOGISTICS SYSTEM

FIGURE 10

MANNED SPACE PLATFORM

OPERATIONS DEMONSTRATION STUDIES

- LARGE SPACE STRUCTURES
  - ANTENNAS
  - OPTICS
  - SOLAR ARRAYS
  - STRUCTURAL DYNAMICS
  - CONTROL SYSTEMS
- SATELLITE SERVICING
  - SERVICE EQUIPMENT
  - TMS UTILIZATION
- FLUID STORAGE AND TRANSFER
  - HANDLING OF CRYOGENIC FLUIDS
  - UPPER STAGE SERVICING
  - ET RESIDUAL FUEL RECOVERY

FIGURE 11

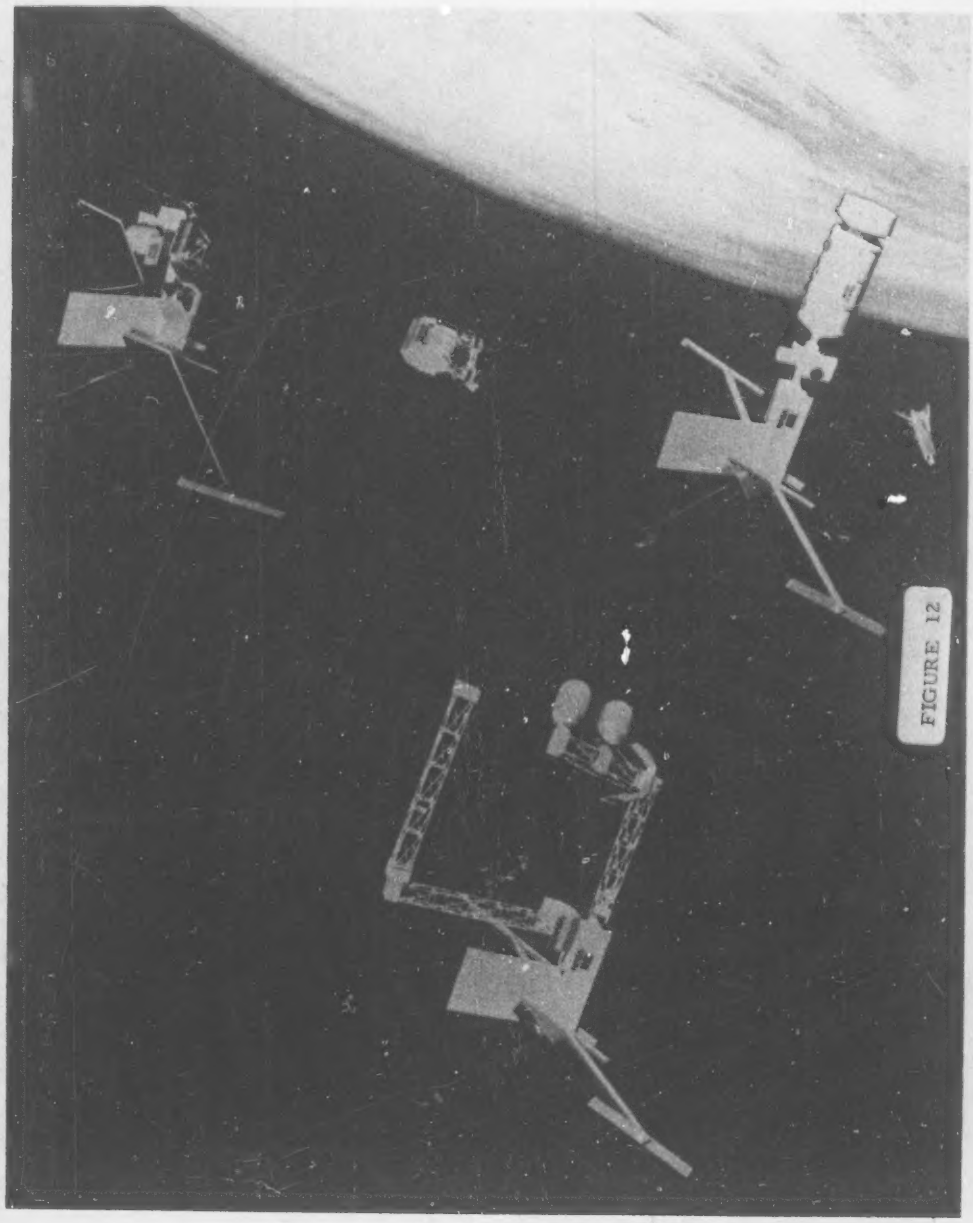


FIGURE 12

SPACE PLATFORM

- COST IS CONSISTENT WITH BUDGET AVAILABILITY
- DESIGN IS COMPATIBLE WITH MULTIPLE FUTURE USERS
- DESIGN DEFINITION AND PROGRAM COST ARE WELL DEFINED
- SPACE PLATFORM IS A LOW COST PROGRAM APPROACH

93-418 1240

FIGURE 13

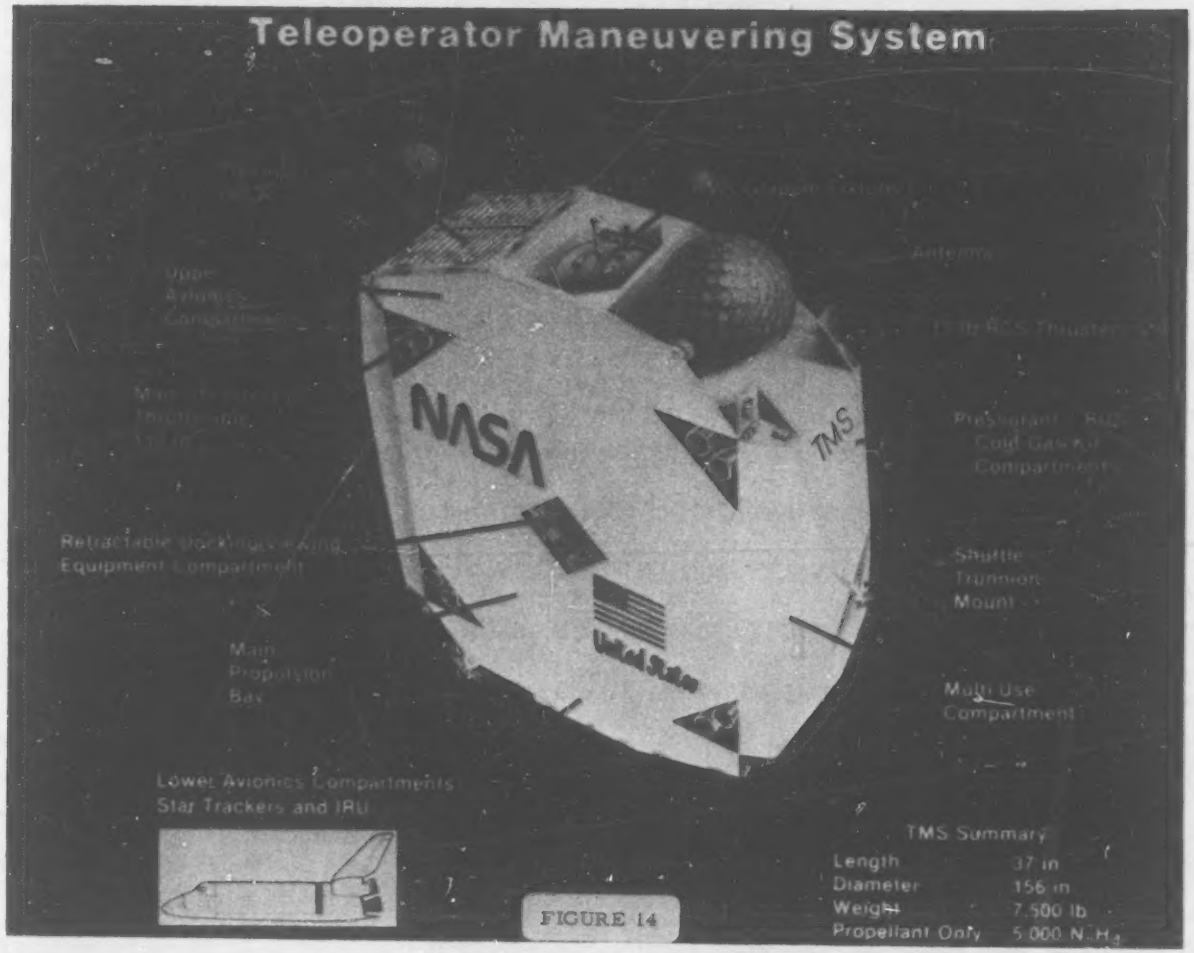

Teleoperator Maneuvering System
NASA
TMS
Upper Avionics Compartment
Antenna
Deep RCS Thruster
Retractable Docking Ring Equipment Compartment
Shuttle Trunnion Mount
Main Propulsion Bay
Multi Use Compartment
Lower Avionics Compartments Star Trackers and IRU
TMS Summary
Length 37 in
Diameter 156 in
Weight 7,500 lb
Propellant Only 5,000 N2H4

FIGURE 14

474-82

TELEOPERATOR MANEUVERING SYSTEM (TMS)

- TMS IS A REMOTELY CONTROLLED, FREE-FLYING, ORBITAL MINI-TUG VEHICLE CAPABLE OF PERFORMING A WIDE RANGE OF REMOTE SATELLITE SERVICES MISSIONS

- TMS ENHANCES THE ORBITER'S CAPABILITY & EFFICIENCY:
  - DELIVERY TO OR RETRIEVAL OF PAYLOADS FROM HIGH ALTITUDE ORBITS
  - MANEUVERING OR REPOSITIONING (PLANE CHANGE) OF P/L'S
  - SUPPORTS P/L'S FOR LONG DURATION ORBITAL STORAGE MISSIONS
  - REMOTE P/L VIEWING (TV), REFUELING; SERVICING
  - PERMITS EFFICIENT CO-MANIFESTING OF P/L'S ASSIGNED TO DIFFERENT ALTITUDES (MAXIMIZES USE OF STS CARGO DELIVERY CAPABILITY TO LEO)

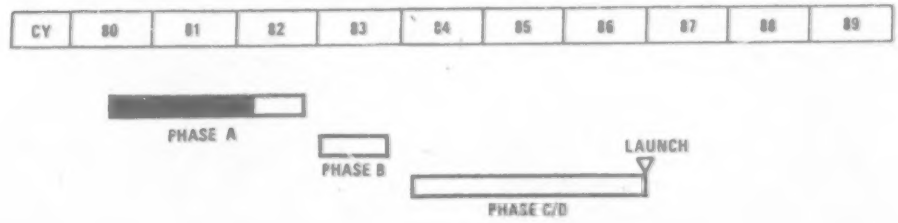


FIGURE 15

TELEOPERATOR MANEUVERING SYSTEM (TMS) APPLICATIONS

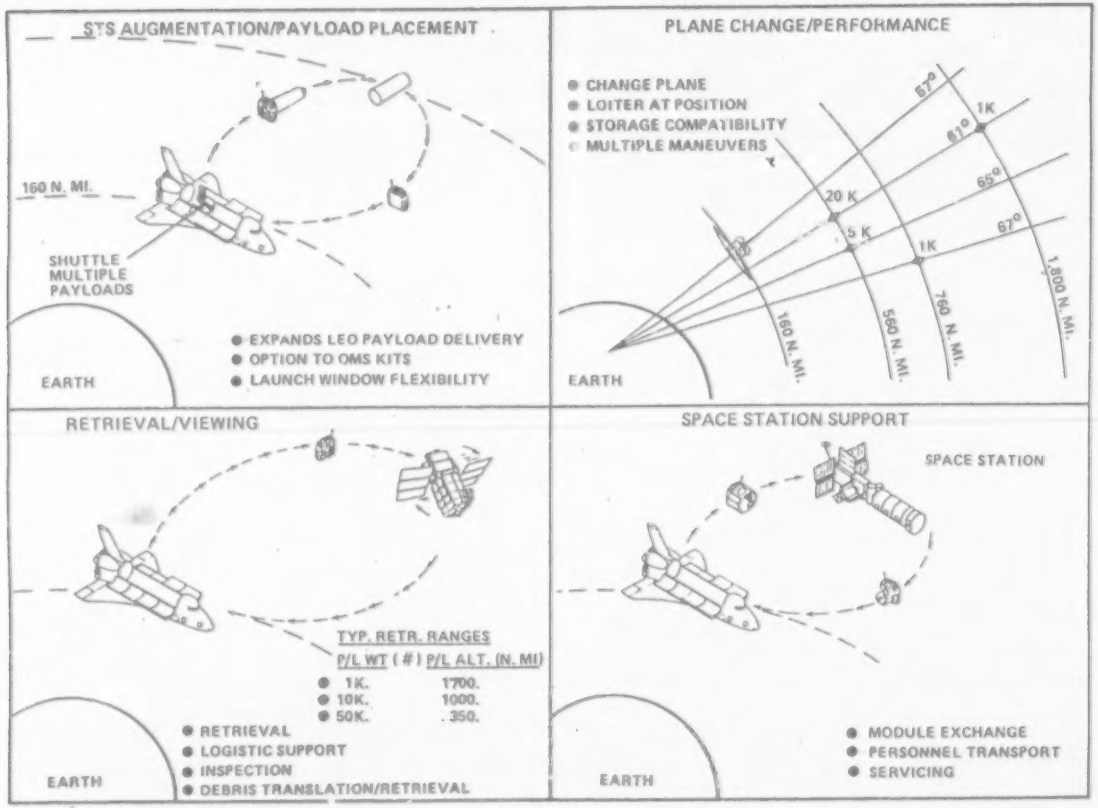


FIGURE 16

93-418 1243

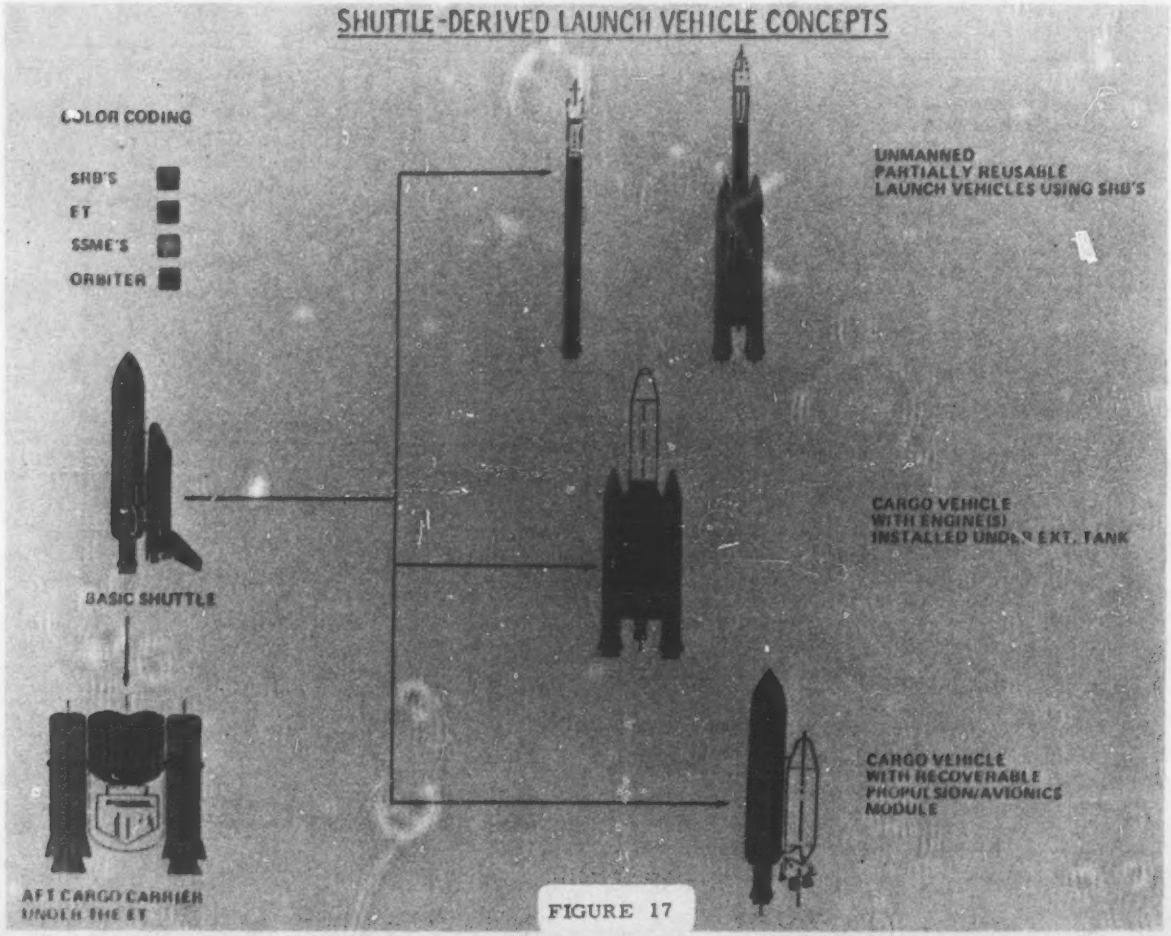

SHUTTLE-DERIVED LAUNCH VEHICLE CONCEPTS
COLOR CODING
SRB'S
ET
SSME'S
ORBITER
UNMANNED
PARTIALLY REUSABLE
LAUNCH VEHICLES USING SRB'S
CARGO VEHICLE
WITH ENGINE(S)
INSTALLED UNDER EXT. TANK
BASIC SHUTTLE
CARGO VEHICLE
WITH RECOVERABLE
PROPULSION/AVIONICS
MODULE
AFT CARGO CARRIER
UNDER THE ET

FIGURE 17

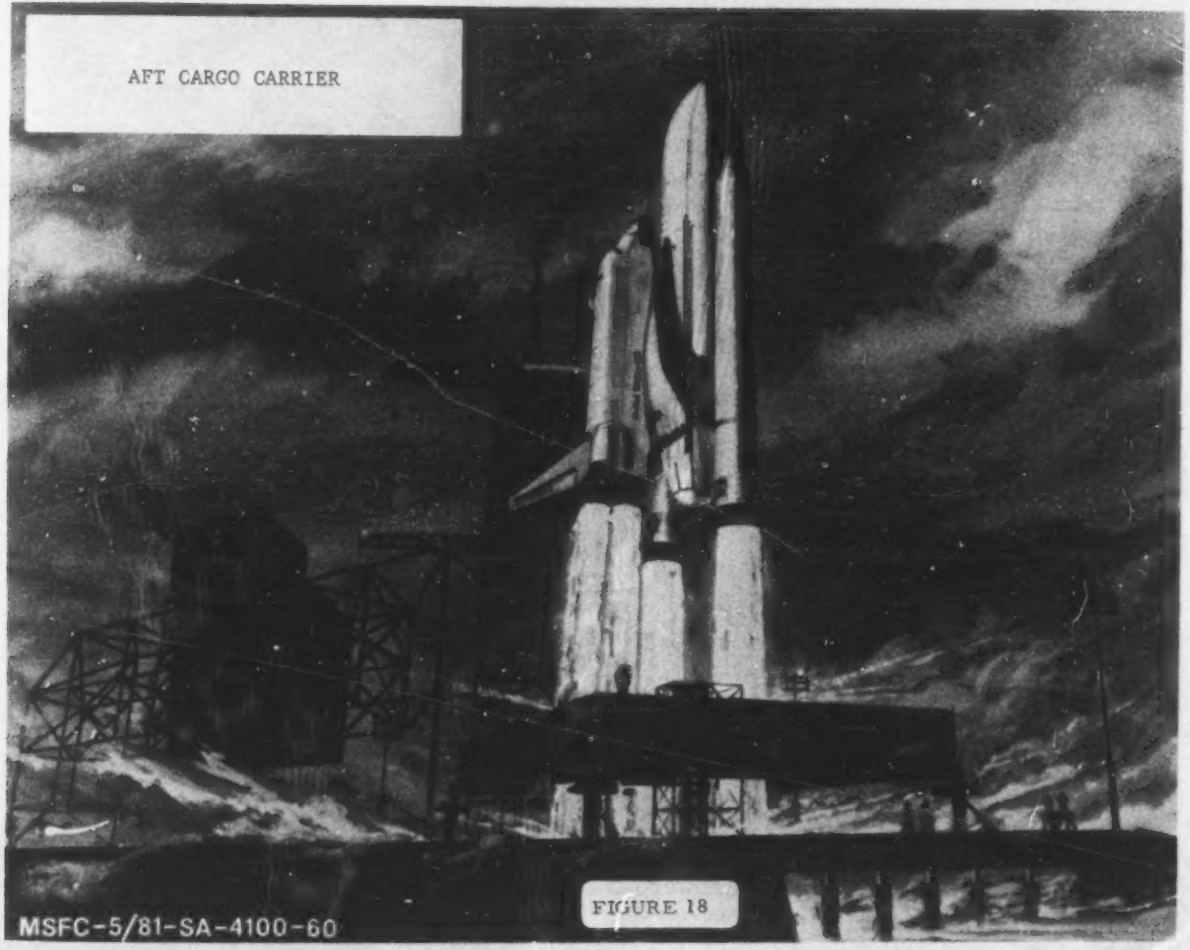
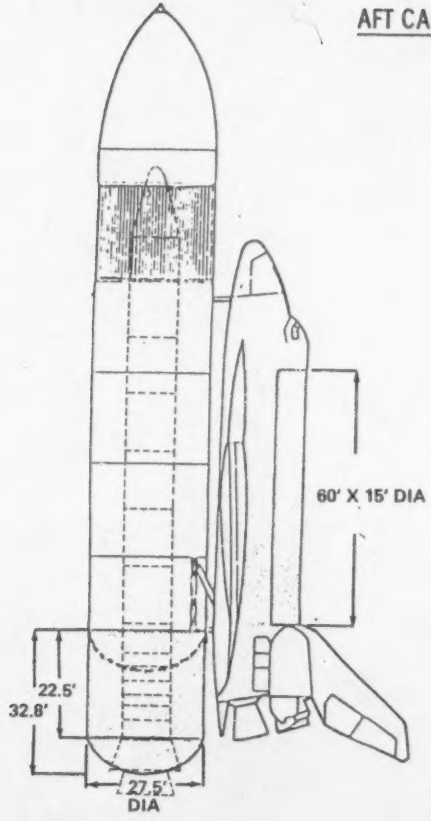


FIGURE 18

AFT CARGO CARRIER (ACC)



- ADDITIONAL PAYLOAD VOLUME:
  - FOR VOLUME LIMITED FLIGHTS
  - FOR PAYLOADS DIFFICULT TO INSTALL IN ORBITER.
- ORBITER CARGO BAY = 10,600 FT^3
  AFT CARGO CARRIER ≅ 13,300 FT^3 (ADD'L).
- POTENTIAL A. C. C. PAYLOADS:
  - SPACE STATION MODULE
  - LARGE STRUCTURES
  - PROPULSIVE STAGE PLUS PAYLOAD
  - CRYOGENIC ORBIT TRANSFER VEHICLE
- ENVIRONMENT
  - ACOUSTICS: APPEARS SOLVABLE, TARGET IS TO MATCH P/L BAY ENVIRONMENT.

FIGURE 19

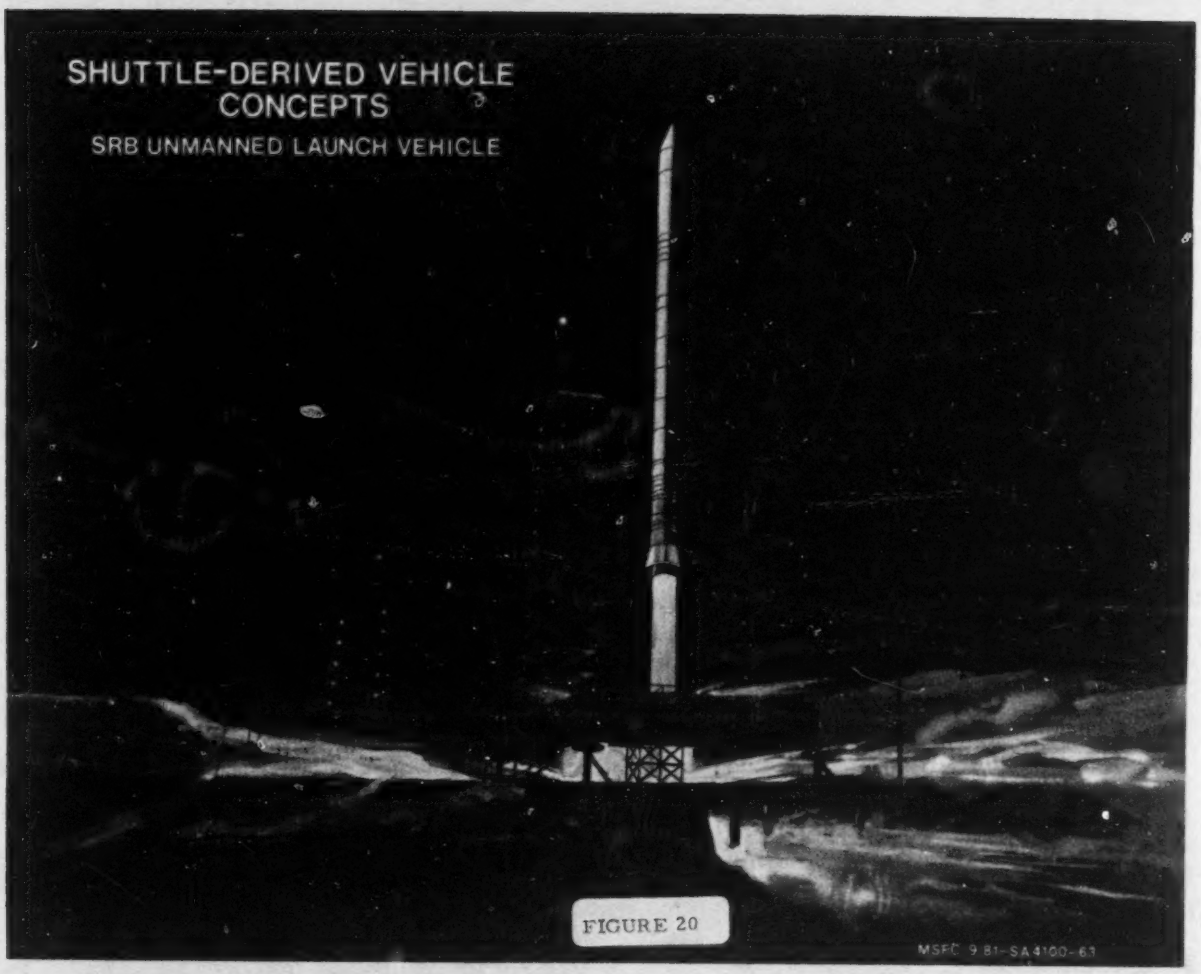

SHUTTLE-DERIVED VEHICLE
CONCEPTS
SRB UNMANNED LAUNCH VEHICLE
MSFC 9 81-SA4100-63

FIGURE 20

SHUTTLE-DERIVED VEHICLE
CONCEPTS
SRB UNMANNED LAUNCH VEHICLE
MSFC 9/81-SA 4100-66

FIGURE 21

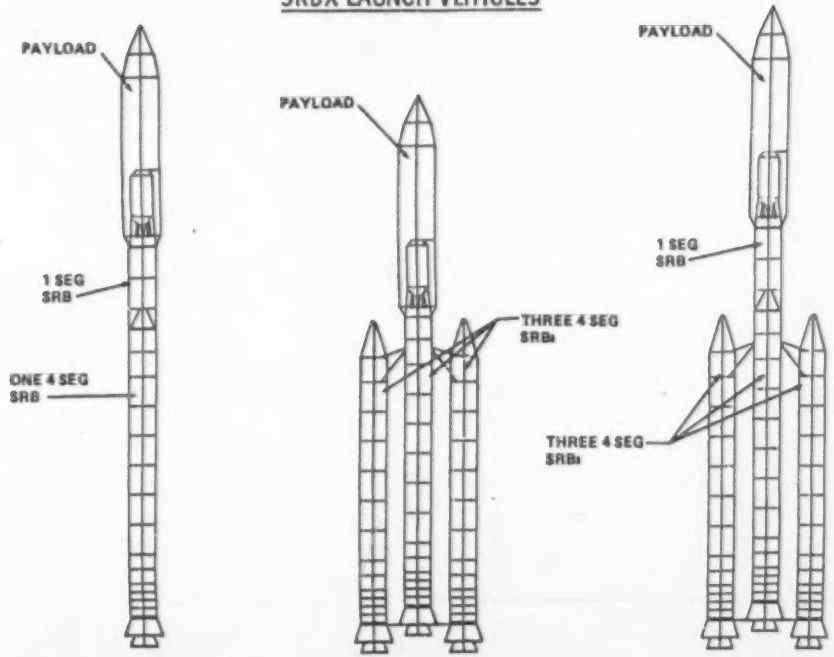
SRB-X
A CANDIDATE FOR MIXED FLEET

- POTENTIAL COST ADVANTAGES TO SRB-X AND SHUTTLE THROUGH SYNERGISM
  - INCREASE BUY OF SRM'S
  - DUAL UTILIZATION OF MFG/LAUNCH GUIDELINES AND OPERATIONS CREW
- IMPROVED MIXED FLEET FLEXIBILITY
  - INTERCHANGEABILITY OF SPECIFIC PAYLOADS AT MINIMUM LEAD TIME
  - REDUCED INVENTORY FOR POTENTIAL INCREASE IN UNMANNED LAUNCH REQUIREMENTS
- PERFORMANCE ADVANTAGE OVER CURRENT ELV'S
- REUSE OF BOOSTERS

FIGURE 22

412–82

SRBX LAUNCH VEHICLES



CONFIG.	SINGLE SOLID BOOSTER (CONFIG. # 3)	DUAL SOLID BOOSTERS (CONFIG. # 4)	DUAL SOLID BOOSTERS (CONFIG. # 6)
PAYLOAD (K–LB)			
LEO	38.9	49.2	75.7
GEO ORBIT	6.7	7.8	13.5

FIGURE 23

FIGURE 24

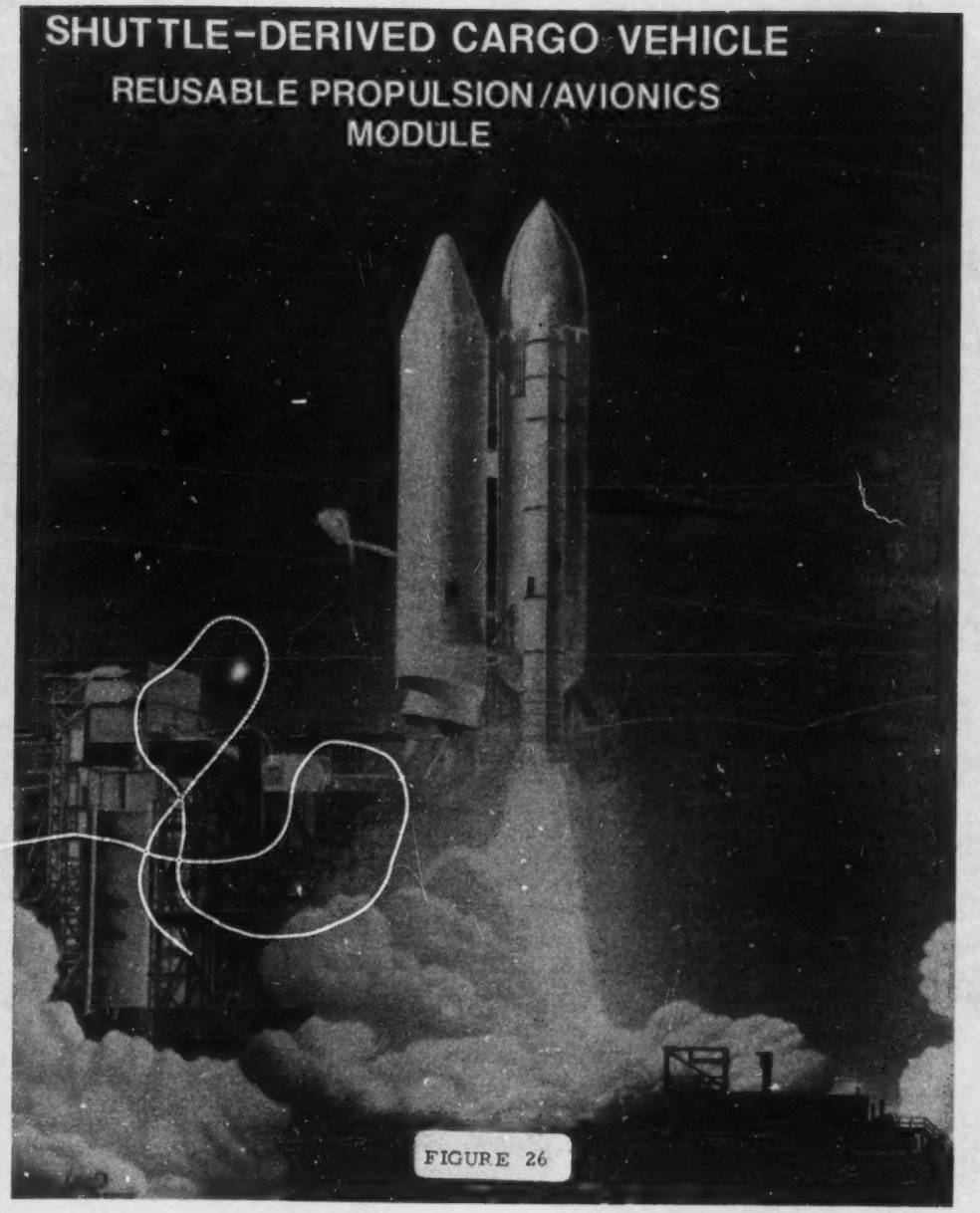

SHUTTLE-DERIVED CARGO VEHICLE
REUSABLE PROPULSION/AVIONICS
MODULE

FIGURE 26

February 12, 1982

STATEMENT

OF

MR. WILLIAM R. MARSHALL
DIRECTOR

PROGRAM DEVELOPMENT
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FOR THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

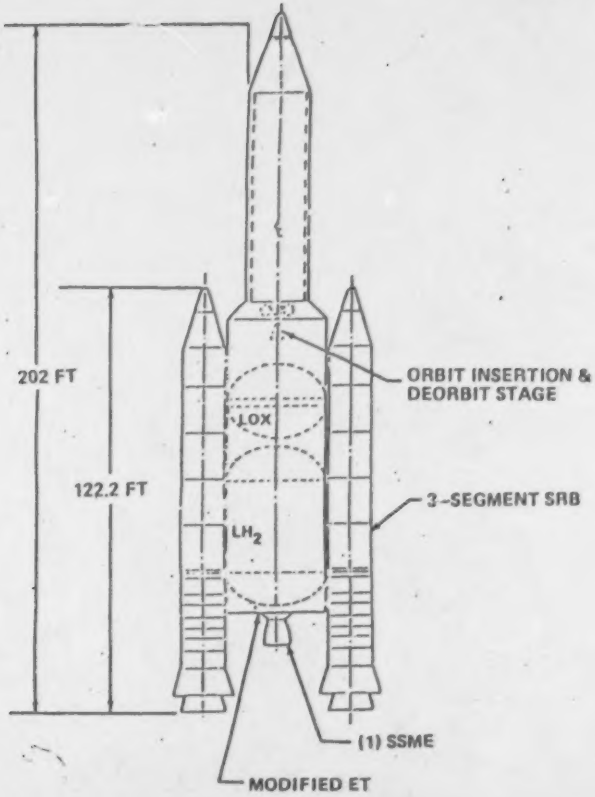
Mr. Chairman and Members of the Subcommittee:

Last year's testimony to this subcommittee described three broad areas of the Marshall Space Flight Center's (MSFC) advanced planning activities -- Science and Applications Payloads, Space Platforms and Large Structures, and Advanced Transportation Systems. During the past year, efforts have continued in these areas.

Our advanced planning activities have emphasized the further definition of a possible Space Platform -- to support Science and Applications Payloads and particularly the future possible evolution of this system to provide a permanent manned presence in space. We have continued the planning efforts for Advanced Transportation Systems and Science and Applications Payloads.

The following information presents the status of current planning efforts and describes several possible uses and courses of action for these projects. Please note however that none of these programs have yet been approved for development. Further, the possible schedules and capabilities discussed reflect one set of a wide range of possible options being developed for future consideration and do not necessarily reflect the current views of either NASA or the Administration.

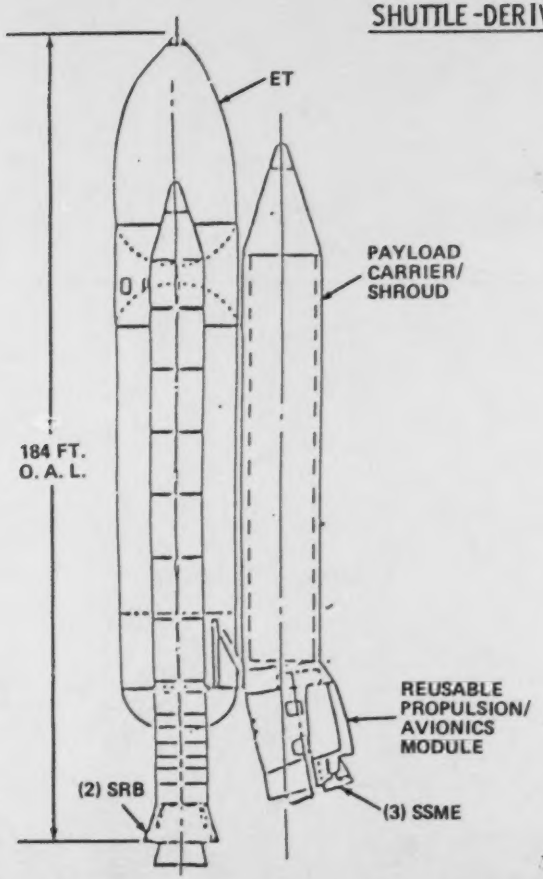
SHUTTLE-DERIVED CARGO VEHICLE (SDCV)



- "IN-LINE" CONCEPT
- 1 OR 2 SSME'S INSTALLED UNDER E. T.
- LOW ORBIT PAYLOAD CAPABILITY:
  - APPROX 80K LBS (SINGLE SSME)
  - APPROX 150K LBS (TWO SSME'S)
- ENGINE/AVIONICS OPTIONS:
  - EXPEND
  - RECOVER VIA ORBITER RETURN

FIGURE 25

SHUTTLE-DERIVED CARGO VEHICLE (SDCV)



- "SIDE–MOUNT" CONCEPT
- ENGINES/AVIONICS/OMS INSTALLED IN RE–ENTRY MODULE FOR RETURN AND REUSE.
- APPROX. 140K LBS. PLD. TO LOW ORBIT
- LARGER PAYLOADS ACCOMMODATED:
  - 15 TO 30 FT. DIAMETER
  - 60 TO 90 FT LONG

FIGURE 27

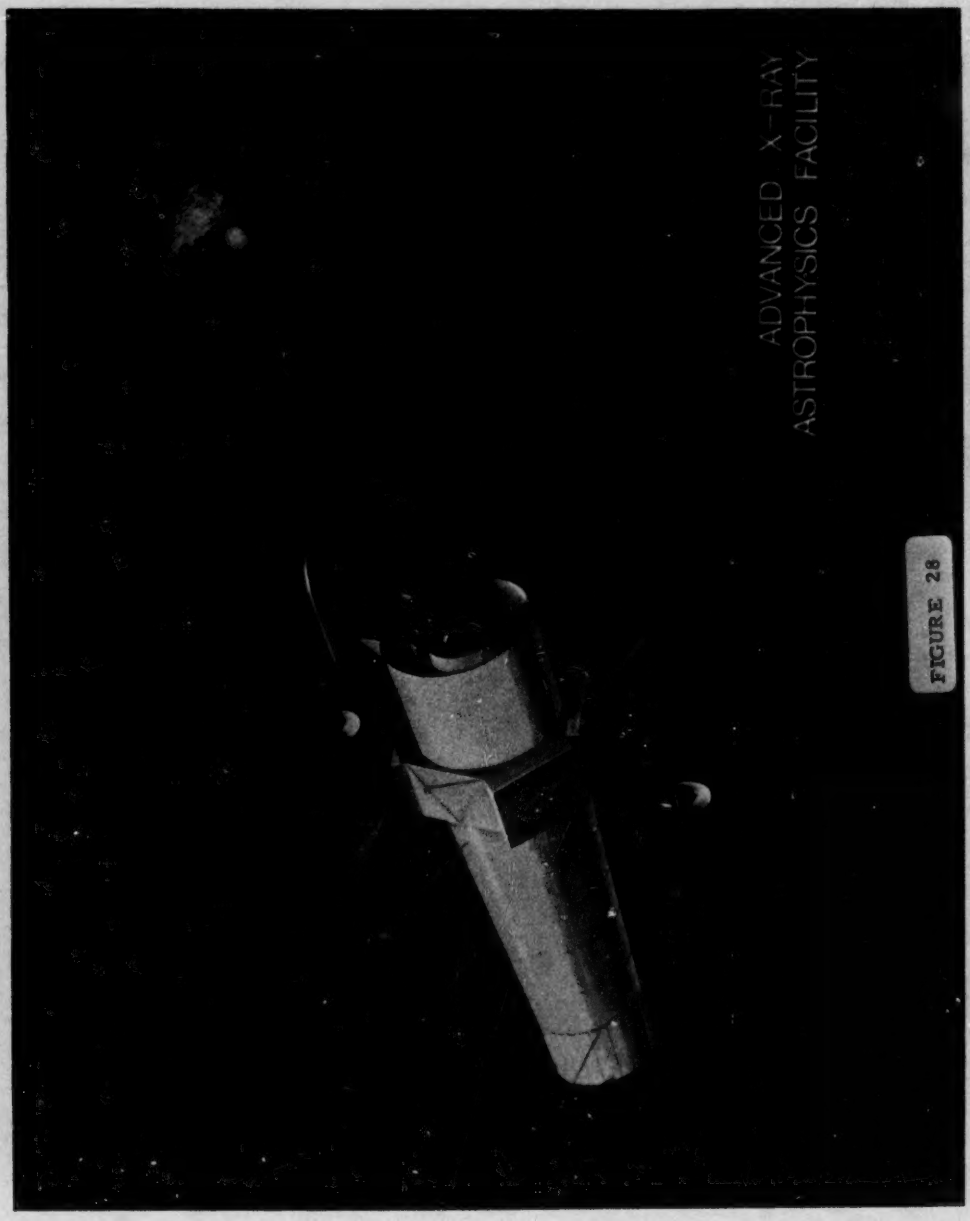


FIGURE 28

581-82

ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF)

X-RAY ASTRONOMY GREATLY ADVANCED BY HEAO

- OBSERVED THOUSANDS OF NEW OBJECTS
- DEMONSTRATED IMPORTANCE OF IMAGE-FORMING X-RAY OPTICS
- INVOLVED HUNDREDS OF SCIENTISTS THROUGHOUT THE WORLD

AXAF WILL PROVIDE:

- IMPROVED ANGULAR RESOLUTION NEEDED FOR DETAILED STUDIES OF SOURCE STRUCTURE
- 100-FOLD INCREASE IN SENSITIVITY WITH IMPROVED ENERGY COVERAGE
- LONG LIFETIME BY USE OF SHUTTLE FOR LAUNCH, REFURBISHMENT, UPDATE AND RETRIEVAL

AXAF ACTIVITIES

- TECHNOLOGY PROGRAM FOR POLISHING, FABRICATION, ASSEMBLY AND TESTING OF LARGE X-RAY MIRRORS
  - TEST FLATS MEASUREMENT PROGRAM
  - PROCUREMENT OF TEST MIRRORS
- ASPECT SYSTEM AND SENSOR STUDIES

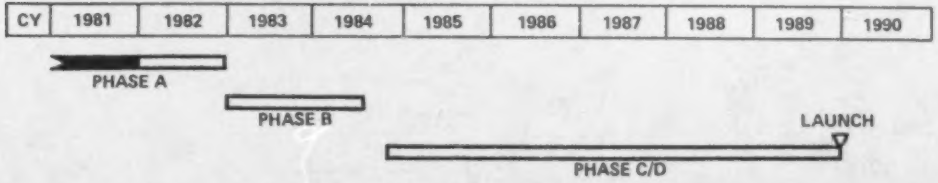


FIGURE 29

SPACE PLATFORMS AND LARGE STRUCTURES

Space Platforms could enhance the utilization of space by supporting science and applications investigations, by combining numerous satellite functions on a single large structure, and by evolving into a free-flying manned system. Large systems deployed, assembled and serviced in space could offer new capabilities for a variety of science, commercial and defense applications. Major emphasis in our advanced planning efforts have been directed toward these important elements.

Manned Space Platform - A Space Platform in combination with the Shuttle/ Spacelab systems and subsystems could enable a transition from the Spacelab sortie mode of manned operations to a free-flying Manned Space Platform (MSP) in low Earth orbit, as shown in Figure 1. Over the past year, MSFC has continued its study and analysis of the MSP to better define a possible evolutionary approach to permanent manned presence in space and to clarify the mission applications for an early manned facility should one be necessary.

The MSP concept depicted in Figure 2 uses the Space Platform, a combined habitability/experiment module which is derived from Spacelab and crew equipment developed for the Shuttle. The basic resources such as power, heat rejection, communications, attitude control and station keeping are provided by the Space Platform. The habitability/experiment module contains the crew support and habitability provisions in addition to experiments and experiment support equipment. A pressurized adapter located between the Space Platform and the habitability/experiment module provides for the structural attachment and crew transfer between the Orbiter and the MSP. An Orbiter type airlock mounted to the pressurized adapter provides for both routine and emergency EVA. The pressurized adapter and EVA airlock also serve as a safe haven for the crew during extreme emergencies or in preparation for crew rescue in case of a mission abort.

A Space Platform, supporting science missions and commercial materials processing, is currently being defined on a schedule that could allow initiation of development activities in FY 1984, leading to an operational capability in 1988, as illustrated in Figure 3. The MSP would begin operations in 1990 and would be used for continued support of those science missions and commercial materials processing activities which would require continued manned support in space. Another important role for the MSP is its use as a testbed for future

space operational capabilities. Recent projections for candidate missions for the Space Shuttle through the year 2000 have identified three key space operations which would support a manned presence in space: (1) assistance in deployment or assembly of large spacecraft systems, (2) periodic servicing of freeflying spacecraft accessible from a manned facility in low Earth orbit, and (3) operational support of spacecraft delivery missions needing high performance propulsion stages. These space operational capabilities call for extensive development and demonstrations in space before implementation into an operational facility will be feasible. While some of the operational capabilities will be demonstrated using the Shuttle, the MSP would allow these operational demonstrations to be exercised for extended periods of time and free from Shuttle constraints. Candidate operations to be demonstrated include deployment/assembly/construction of large antennas/solar arrays/ optics, spacecraft servicing, and propellant handling and servicing of orbit transfer vehicles.

During 1982, MSFC will continue to define this evolutionary approach to a Manned Space Platform with emphasis on the early missions that require a manned facility. Technology and advanced development activities are being focused to support this development.

Experimental Geostationary Platform - Geostationary satellites in operation today are serving a multitude of national, foreign, and international needs. Characteristically, the satellites are small, and for the most part serve the needs of only a single user.

The current operational system now serves the U.S. and foreign elements well. However, the trend is toward larger, more complex satellites. This is driven by cost benefits from size, the desire to accommodate more than one mission or frequency on a single satellite, and the increasing size and resource requirements for future missions. Examples of this trend are the Tracking and Data Relay Satellite System (TDRSS) and the Intelsat V.

Studies of operational geostationary platforms for the 1990's have shown technical and economical superiority for achieving future geosynchronous missions versus missions utilizing individual smaller satellites. These platforms would be located to serve geographical areas of high population density (e.g., the U.S. and Western Europe). Interplatform links would allow communications between platforms in the same constellation, (i.e.,

cluster) as well as between platforms in different constellations. Such platforms, because of their large size would be able to accommodate future communications, meteorological, scientific, and other missions at a much lower cost than small satellites. These platforms would accommodate multibeam antennas operating at multiple frequencies and interconnectivity between beams. This mode of operation provides a solution to the congestion of the geostationary arc and frequency spectrum.

The mission objectives of the Experimental Geostationary Platform, depicted in Figure 4, are to develop and demonstrate the technologies, systems, and operational capabilities necessary to implement operational geostationary platforms during the 1990's and to provide an opportunity to test new payload technologies and/or services. Results of studies over the past year have identified platform technologies that require demonstration in order to achieve the projected missions for the decade of the 1990's.

Work over the past year has also included monitoring an active interface between NASA and the user community. One major effort was a three day "Industry Briefing and Workshop on Geostationary Platforms" held in March, 1981 which provided valuable insight into the technical, institutional and operational aspects of platforms.

Current planning anticipates the initial development work on this platform to begin in FY86, with a launch by 1990.

LARGE SPACE STRUCTURES (LSS) - MSFC is organized to develop the fundamental technologies needed to meet the needs of future projects requiring large structures in space. Programs being considered include unmanned space platforms, advanced communication systems, geostationary platforms, and manned space stations. There are three principal construction methods that MSFC has been studying and evaluating over the past several years. They are:

a. Deployable techniques, where the structure is built on the ground and unfolded or automatically deployed in space.

b. Erectable methods, where the structural members are fabricated on the ground and assembled in space.

c. Space fabrication, where the structure is both fabricated and assembled in space.

To assure that the capabilities needed are available on a timely basis, MSFC is presently involved in a number of hardware design, development, ground test, and flight test definition activities, some of which are summarized below.

LSS Systems Engineering (Figure 5) - A large deployable truss has been fabricated and will soon undergo a series of automatic deployment, load, and vibration tests at one of MSFC's LSS test facilities. This truss is a major structural element of an orbital space platform, and will be capable of distributing utility services.

Analyses of manned physical requirements for various structural fabrication, joining, attachment, and assembly techniques is continuing in MSFC's Neutral Buoyancy Simulator for a variety of candidate design approaches. Special tools, handling aids, and assisting mechanisms (i.e. manipulator systems) are also being assessed in a simulated space environment. These ground simulation efforts will guide the design of future space structures.

NASA satellite programs have employed the use of short masts up to 18" in diameter to automatically deploy communication antennas, as shown in Figure 5. Future Space Platform and satellite programs involving large deployable solar arrays or large antennas would require much larger diameter and longer deployable masts, with much greater load carrying capabilities. MSFC has initiated a two year technology program to develop, test, and verify the capabilities of a large 30" diameter deployable mast system, up to 50 feet in length. Correlation between ground test and analysis to orbital performance must be developed for future ground validation of orbital structures.

MSFC is nearing completion of the fabrication of a large deployable solar array wing (approximately 100 feet long) to be flight tested on STS-14. Related remote sensing instrumentation and systems integration activities are underway to support planned deployment, thermal, and dynamic testing while on orbit.

Deployable Antenna Flight Experiment - Space flight test of a large (50 m diameter test article) deployable antenna, as shown in Figure 6, is a key step in development of, precision space structures and verification of design data for antenna user programs. Multibeam communication satellites, spacebased radar, soil-moisture radiometers, very long baseline interferometers, and deep-space relay satellites will utilize large antennas.

The proposed large antenna test structure would be a reusable test-bed and would remain attached to the Orbiter for the flight measurement program. Primary verification tests are zero-g deployment and measurement of the dimensional accuracy and stability of the antenna structure under varying thermal environments and attitude control excitations. Additional candidate mission objectives include the mapping of radio frequency patterns generated by the large aperture.

Parallel definition study contracts now in process are addressing multi-user applications and technology objectives important to both civil and military programs. This development test flight is proposed for 1987.

Shuttle/Tethered Satellite System - The Tethered Satellite System (TSS) would use the Space Shuttle to extend scientific exploration capabilities. The TSS would provide the means to deploy subsatellites from the Orbiter at distances up to 100 km, maintain them in a flight profile, and reel them back into the Orbiter cargo bay, as illustrated in Figure 7. When deployed from the Orbiter toward the Earth, a tethered scientific package can remain in a very low orbit for extended periods. A low orbit increases the resolution capability of gravity and magnetic field mapping experiments and allows continuous mapping of the Earth's upper atmosphere, ocean topography mapping, low frequency communications, and radiation surveys. When deployed upward, away from the Earth, an electrically conducting tether can be used for power generation and plasma physics experiments.

Current planning is based on the prospect of a cooperative U.S./Italian development activity wherein the U.S. would develop the TSS deployer and carry out overall system integration, and Italy would develop a facility-type satellite capable of multiple missions. A U.S./Italian Science Working Group has been formed to develop requirements and effect planning for joint U.S./Italian use of the TSS. During the feasibility phase a Facility Requirements Definition Team was formed to define science uses and determine system requirements for the TSS.

A two-phase development approach is being planned wherein Ball Aerospace and Martin Marietta will be invited to bid on an Advanced Development and a Design/Development phase.

ADVANCED TRANSPORTATION SYSTEMS

Efforts at MSFC to support propulsion and space transportation capabilities include systems definition of orbital transfer vehicles and utilization of Shuttle developed technology to define new unmanned launch vehicles. Studies and technology work toward more advanced launch vehicle concepts continue.

Teleoperator Maneuvering System - As the Shuttle system becomes a reality the need for a "mini tug" free-flying system becomes more apparent. MSFC has conducted supporting system studies in this area. These studies have shown that Shuttle utility could be enhanced via a free-flying upper stage to deliver and retrieve payloads for the Shuttle. Services that the Teleoperator Maneuvering System (TMS) could provide are spacecraft delivery, retrieval, payload viewing, debris retrieval, satellite servicing via major module or element exchange, assembly of large structures, major systems orbit reboost and/or deboost, payload plane changes, satellite refueling, and subsatellite science support. The TMS would also provide logistic support to low Earth orbit space platforms, and to geosynchronous space platforms as well, when delivered to the geosynchronous orbit by a companion Orbital Transfer Vehicle (OTV).

The TMS concept is being developed in a modular form which would permit adding functions as they become needed, thereby reducing early year funding requirements. An evolutionary approach could be initiated by developing the OMS tankage to be compatible with the TMS propulsion system requirements. The propulsion system would be added and kits like the avionics, rendezvous radar, television systems, docking devices and/or specialized manipulator systems as mission requirements define the need. This, and other evolutionary approaches are being evaluated by MSFC.

MSFC is ready to proceed with specifications and procurement actions for definition and development activities leading to TMS availability in the 1986-87 time period.

Orbit Transfer Vehicles - As the level of activity at geosynchronous orbit (GEO) increases toward the end of the 1980's, it would be desirable to provide a versatile, reusable Shuttle upper stage with greater payload capability, thereby extending Shuttle type reusability to GEO. A class of reusable upper stages for such advanced missions are referred to as "Orbit Transfer Vehicles (OTV)."

Studies have identified the potential need for a short OTV in its early operational time period to accommodate very long payloads. Configurations, such as the one illustrated in Figure 8, which minimize stage length while maintaining high performance levels, are being studied. initial OTV would be designed for the later modular addition of an aeroassist mission kit. This kit will take advantage of aerobraking techniques upon OTV return to low Earth orbit, thereby attaining significantly increased GEO payload capability in the reusable OTV mode. A full-capability aeroassist OTV, later combined with a crew module, could then accommodate manned sortie missions to GEO or other high energy orbits. If development of a reusable, aeroassisted OTV was initiated in 1984, operational unmanned flights could begin in 1988. Concept studies and technology efforts in propulsion systems, cryogenic systems, and aeroassist provisions are being pursued to build an adequate foundation for reusable OTV development.

Shuttle-Derived Vehicles - Continuing studies of Shuttle-Derived Vehicles show that the basic Shuttle elements can be adapted in a variety of ways to meet potential future space transportation needs. Some of the concepts are shown in Figure 9.

In the event the need develops for an unmanned launch vehicle as a companion to the Shuttle, the basic propulsive elements of the Space Shuttle could be adapted to provide this capability in a very effective manner. For Titan-Shuttle class payloads, unmanned launch vehicles using the Shuttle solid rocket boosters (SRB) could provide this capability with a minimum of new developments and with maximum commonality with the on-going Shuttle program. These are called SRB-X vehicles. Use of such vehicles would increase the availability of Shuttle/Orbiters for missions requiring manned participation and/or roundtrip payload capability.

Shuttle-Derived Launch Vehicles employ a combination of SRB's, External Tank (ET) and Shuttle Main Engine (SSME's) that could provide the capability to launch payloads much larger and heavier than can be launched with the Shuttle Orbiter. Two versions of such "cargo vehicles" are currently under study. In one case the engines and payload are mounted in the same location as in the Shuttle Orbiter ("side-mount" version). The possible desirability of installing the engine(s) beneath the ET and payload above the ET is being examined in the "in-line" class cargo vehicle. These vehicles would carry additional payload or cargo to orbit, in lieu of the Orbiter hardware weight

associated with crew accommodations and payload return capability.

As a further future possibility, reusable liquid rocket boosters are being studied as potential replacements for the solid rocket boosters. The liquid boosters could offer increased payload capability and attractive operating costs, but would require development investment. Two methods of recovery are being examined for the liquid boosters. One would involve down-range recovery from the ocean in a manner similar to that now being used for SRB's; the other considers winged boosters equipped for fly-back and landing at the launch site.

The "Aft Cargo Carrier (ACC)" concept as illustrated in Figure 9 is being examined as a means to provide additional payload-carrying volume for the Shuttle, or for the uprated Shuttle using liquid rocket boosters.

SCIENCE AND APPLICATIONS PAYLOADS

MSFC continues the planning, analyses and technology efforts for future Science and Applications payloads. Payload areas under study range from the large observatory class projects to Shuttle-borne experiments. An important class included in our studies are several Space Platform payloads.

Advanced X-Ray Astrophysics Facility (AXAF) - Imaging X-ray astronomy, ushered in by the HEAO-2 High Energy Astronomy Observatory (Einstein), can expect to experience an improvement of up to 100-fold when AXAF is launched at the end of the decade. This large advance is based on the increase in the sensitivity of its instrumentation due to the significant technological advances and to the capabilities of the Shuttle to place large, sophisticated payloads into orbit and service them over extended periods of time. Because of the scientific expectation from AXAF and the promise of X-ray astronomy unveiled by HEAO-2 and its predecessors, the National Academy of Sciences has recommended AXAF as the highest priority for new observatory class scientific missions for this decade.

The technological advances that would be available for the X-ray telescope include the new generation solid state star trackers, which would permit accurate location of each X-ray object and its structural details, and the improved techniques for grinding, polishing and measuring the figure and scattering properties of X-ray reflecting surfaces.

While the star tracker technology is already finding its way into space applications, the advances in X-ray optics are expected to be demonstrated in a program now underway at Perkin-Elmer Corporation and the ITEK Corporation. These "optical houses" are under contract to MSFC to grind and polish fused silica blanks, as shown in Figure 10, to the shape and surface finish required by the AXAF. Although the mirrors now being procured will not be the full size of the flight mirrors, they are expected to prove that the required surface properties are achievable and that the assembly and alignment of the optical elements to the required accuracies can also be accomplished. Detailed evaluation of the mirrors using X-ray beams, simulating X-ray emitting objects in space, will be performed in the X-ray Test and Calibration Facility at MSFC.

The definition phase for the overall AXAF program is scheduled to be initiated with Request for Proposals to industry later this year. Two parallel contracts are planned, each for definition of the entire AXAF system, less the instruments. The instruments will be selected for defintion from responses to an Announcement of Opportunity planned to be released by the Office of Space Science and Applications and will be contracted for separately. The request for development of AXAF as a New Initiative could occur as early as 1985.

Gravity Probe B - The Gravity Probe B (GP-B) depicted in Figure 11 is an experiment assembly which is capable of accomplishing one of the few known laboratory tests of general relativity. The experiment seeks to measure the two components of the extremely small precession of a gyroscope as predicted by general relativity. In the low Earth orbit proposed for GP-B, the larger component is 6.9 seconds of arc per year, while the smaller component (known as the motional or gravimagnetic effect) is only 0.050 seconds of arc per year. The gravimagnetic effect is the gravitational analog of magnetism. Neither its magnitude nor its existence has ever been demonstrated in any other test of relativity. Only in a satellite where the support forces on the gyroscope can be minimized is it possible for the relativistic precession to dominate the precession attributable to classical sources.

The heart of the relativity gyroscope experiment is the four ultra-stable quartz gyroscopes. The gyroscopes are contained in a quartz block to which an all quartz telescope is attached. This entire assembly is enclosed in a superconducting magnetic shield which in turn is contained

inside a liquid helium dewar. The dewar is the main body of the spacecraft, and when the other necessary subsystems are added to it, the result is the GP-B spacecraft experiment assembly.

Current planning is for the in-house Phase B study, which began in November 1980, to continue through the end of the calendar year 1982. A new start could be initiated in about one year. In parallel with the Phase B study and continuing into early FY 1984, an aggressive advanced technology program is in progress.

Space Platform Payloads - Potential Space Platform offers a multiple payload facility that would supply berthing and utilities to several separate payloads for extended periods. This capability is very important for those investigations that require multiple instruments and long observing times. We are continuing the indepth analysis of candidate Space Platform payloads, four of which are discussed below.

One of the candidate payloads is the Very Long Baseline Interferometer (VLBI). Dramatic improvements in angular resolution of the brightness distribution of extragalactic radio sources have been achieved in recent years by using interferometric techniques employing widely separated radio telescopes on the Earth's surface. The Space Platform provides a unique opportunity to extend VLBI to space. In this configuration shown in Figure 12, an antenna aboard the Platform serves as one of the observing antennas, while one or more ground stations provide the others. MSFC is also studying a demonstration of the Orbiting VLBI technique as part of the Deployable Antenna Flight Experiment, discussed elsewhere in this statement.

Another of the candidate payloads is the Large Area Modular Array of Reflectors (LAMAR). The radiation from very distant sources in the Universe is weaker and thus requires large area collectors for astronomical observations. This is the case in X-ray astronomy where, despite its relatively short history, a high degree of maturity has been reached and questions have arisen which will require studies of weak sources. However, the applicability of a large collecting area is limited unless it is accompanied by good angular resolution of the order of an arc minute to reduce background and to avoid source confusion.

The LAMAR is an X-ray astronomy facility which combines large effective area and good angular resolution. The

concept consists of an array of identical modules containing 100 imaging X-ray telescopes and detectors. Although the LAMAR resolution is modest compared to that of the HEAO-2 or the planned AXAF, its area is so much larger that it has important capabilities that cannot be duplicated by these missions.

The Pinhole/Occulter Facility (POF), illustrated in Figure 13, is an important Solar Terrestrial payload. Studies have been conducted which verify the engineering feasibility of this experiment. A Science Working Group defined the science objectives and mission requirements.

The unique capability of the POF is the ability to perform high energy imaging of the solar disk and celestial objects in spectral ranges unattainable with other instruments and to very high resolution (1 arc-sec and better). In addition, the simultaneous use of the pinhole mask as an external occulter allows study of the Sun's corona with better resolution, spectral range, and sensitivity than in the past and also allows such observations much nearer the Sun's limb. Such observations are key to our understanding the Sun, the energy transport mechanisms of the chromosphere and the origins of the solar wind. This in turn is the key to understanding the entire Solar Terrestrial environment, including its effects upon the Earth's atmosphere and weather, impacts upon our communications systems as well as other effects of the great solar storms.

The fourth candidate payload to be discussed is the Solar Terrestrial Observatory (STO). The STO is a problem-oriented instrument payload based on a Shuttle/Platform approach, i.e., the payload, consisting of a combination of solar, magnetospheric and atmospheric instruments, is located on a Space Platform and is established, serviced and retrieved by the Space Shuttle. The central scientific goal of the STO is to understand the physical processes that couple the major regions of solar terrestrial space. The initial STO instruments will make use of refurbished and updated Spacelab instruments that have previously flown in space.

Advanced Optical Systems - Scientific investigations in ultraviolet and visible astronomy planned in the 1990's and beyond will require high imaging resolutions and very large collecting areas. To meet these requirements, a comprehensive program must be formulated that makes use of the Space Transportation System, the advanced technology from the Space Telescope Program, and new technology.

In recognition of this, several concepts for advanced space telescopes are being studied.

One system, now under study by MSFC and the Smithsonian Astrophysical Observatory, avoids some of the difficulties of on-orbit assembly. This Optical Interferometer is a Coherent Optical System of Modular Imaging Collectors (COSMIC).

Shuttle Time and Frequency Experiment - Time and frequency are fundamental parameters in many scientific investigations as well as navigation and communication. A large number of atomic clocks are in use around the world to provide extremely accurate time and frequency information. In many cases, very accurate comparison and synchronization of clocks separated by large distances are required. Examples include the generation of the atomic time scale involving primary standard laboratories in several countries, research on advanced time and frequency standards, radio astronomy, geodynamics research, and NASA's Deep Space Net.

A new technique, illustrated in Figure 14, for increased accuracy global time and frequency transfer is being studied at MSFC. The concept uses a hydrogen maser clock in a space vehicle with an accuracy of 1 nanosecond (10^{-9} sec) and direct frequency transfer capability accurate to one part in 10^{14} between separated clocks. The high accuracy direct frequency transfer is a unique feature of the proposed system.

The proposed implementation of the new system involves a demonstration experiment aboard the Space Shuttle. After verification, the system could be placed aboard a Space Platform and/or a free-flying satellite to provide global synchronization of time and frequency standards. Preliminary system studies with participation from the U.S. Naval Observatory, the National Bureau of Standards, the Smithsonian Astrophysical Observatory and the University of Maryland, will be completed during FY82.

Doppler Lidar Wind Measurement System - A laser radar, or LIDAR (Light Intensification, Detection and Ranging), would be capable of measuring the winds over a large portion of the globe from space as shown in Figure 15. Such global wind measurements would be of immense utility to both the operational and research activities of the civilian and military meteorological organizations. NASA, NOAA, and the Air Force are currently coordinating an

assessment of the satellite system technology requirements.

The first airborne scanning LIDAR, developed at MSFC, has just finished a highly successful measurement season. Important research data in a variety of different atmospheric conditions have been obtained. Mounted in NASA's CV990 aircraft and using the aircraft motion and a scanning system to probe the same volume from different angles, the airborne system uses principles similar to the proposed satellite system. The results will be of significant use in research efforts dealing with flow about complex terrain, thunderstorm gust fronts, pollution transport in local flows, and cloud physics. In the summer of 1982, the scanning system will be mounted in a trailer for participation in a cooperative experiment investigating the effects of thunderstorms on airport operations. In the summer of 1983, another flight research program is planned in the CV990 aircraft.

Lightning Mapper Payload - The development of satellite techniques to detect and locate lightning has been motivated by both a pursuit of scientific knowledge and a need for a comprehensive warning and avoidance system. It has been determined that a sensor located in a geostationary orbit with detection and location capability and appropriate data dissemination would satisfy the majority of the user requirements. In order to better define a lightning detector, MSFC has been pursuing exploratory experiments using a NASA U-2 aircraft to overfly thunderstorms in parallel with studies addressing sensor characteristics. Also, on the second Space Shuttle flight, a small lightning sensor, was operated by an astronaut, as an exploratory experiment. It is anticipated that the instrument will be reflown on the fourth and sixth Shuttle flights.

In the summer of 1981, an array of seven instruments aboard the U-2 was used to measure the spatial and temporal characteristics of the optical emissions from lightning from above the cloud top. Continuation of the airborne experiments and those aboard the Space Shuttle in 1982 is expected to produce more detailed information on lightning, as seen from the cloud tops. It is anticipated that this research will yield the quantitative data base required for the design of an optical lightning mapper sensor. The second primary effort during 1982 will be a detailed satellite sensor study. This work will address the requirements of a lightning sensor design as a function of present technology. Results to date indicate that an optical lightning sensor system in geostationary orbit

as illustrated in Figure 16 is feasible and will produce unique and valuable data for operational support and research purposes.

This overview of MSFC's current planning activities is representative of the breadth and balance of the center's Advanced Systems efforts. Advanced planning includes the immediate future as well as more distant programs. The Marshall Center continues to make a firm commitment to the careful planning of the nation's future space program.

[Figures 1-16 of Mr. Marshall's prepared statement follow:]

TRANSITION TO MANNED SPACE PLATFORM

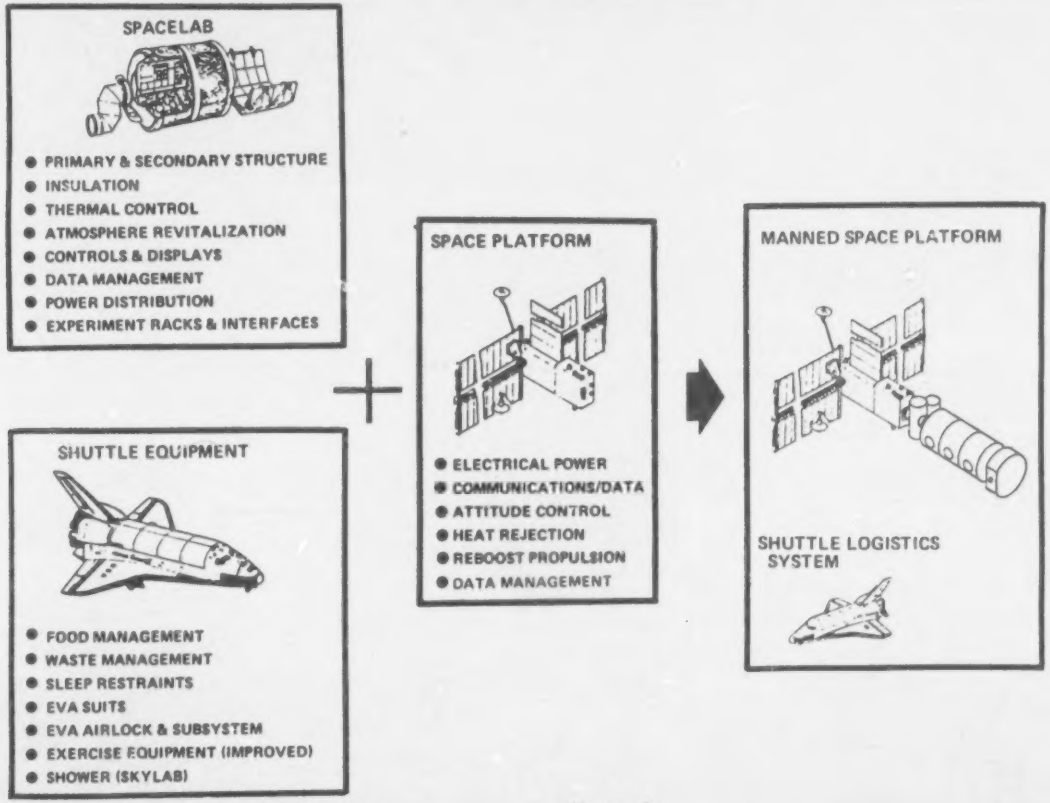


Figure 1

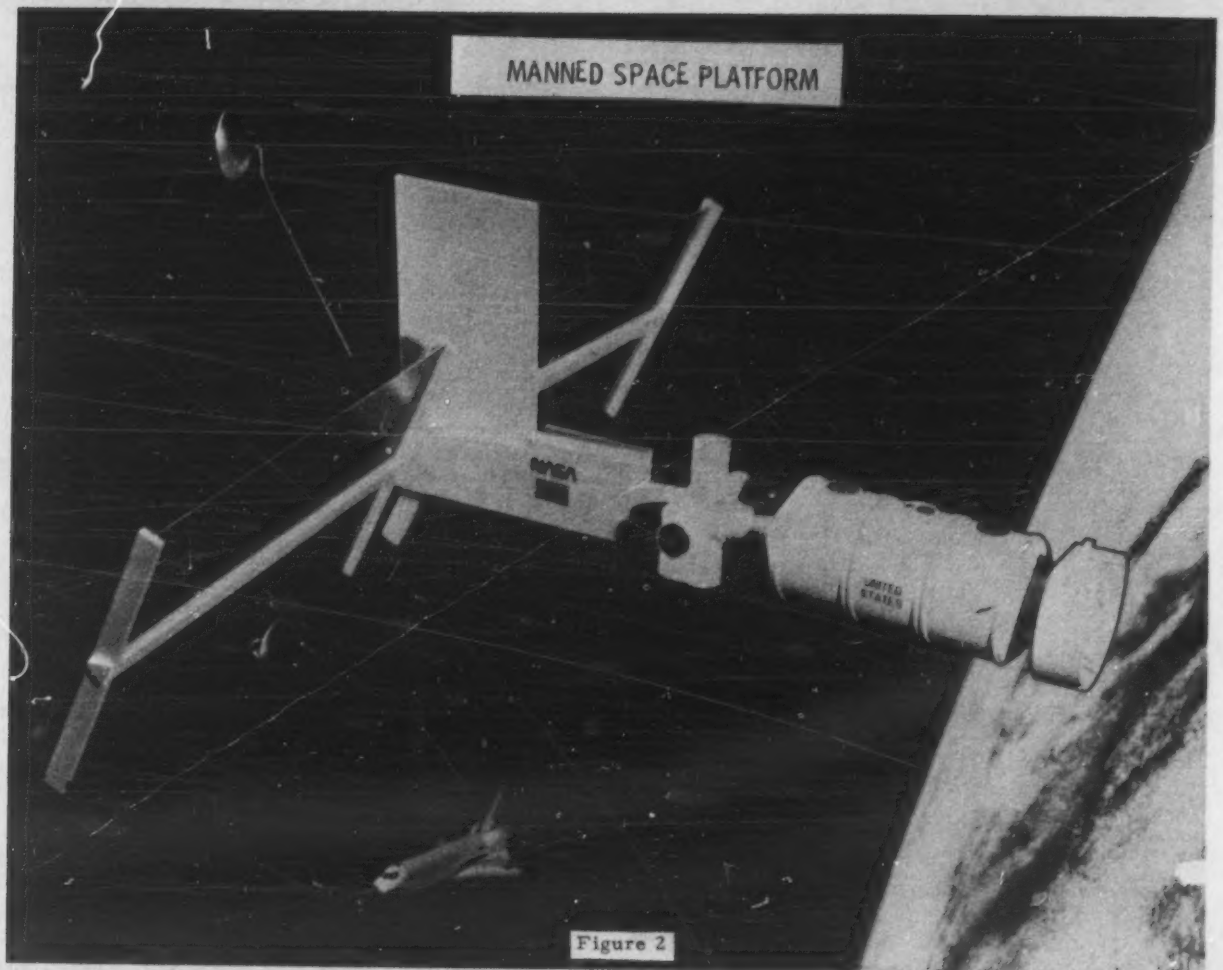


Figure 2

187-82

PLATFORM UTILIZATION

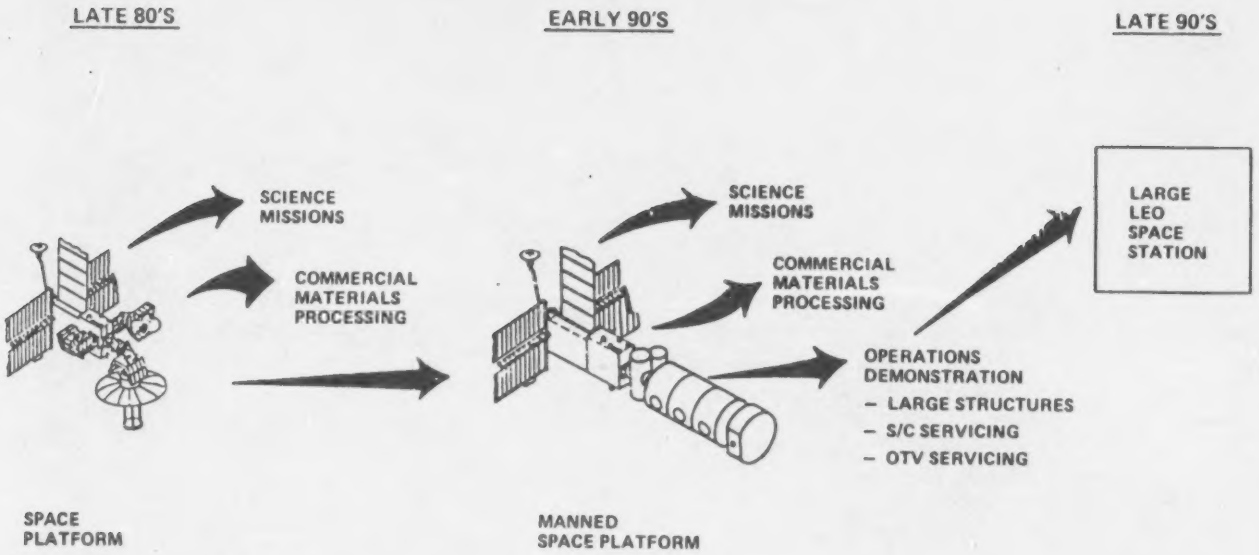


Figure 3

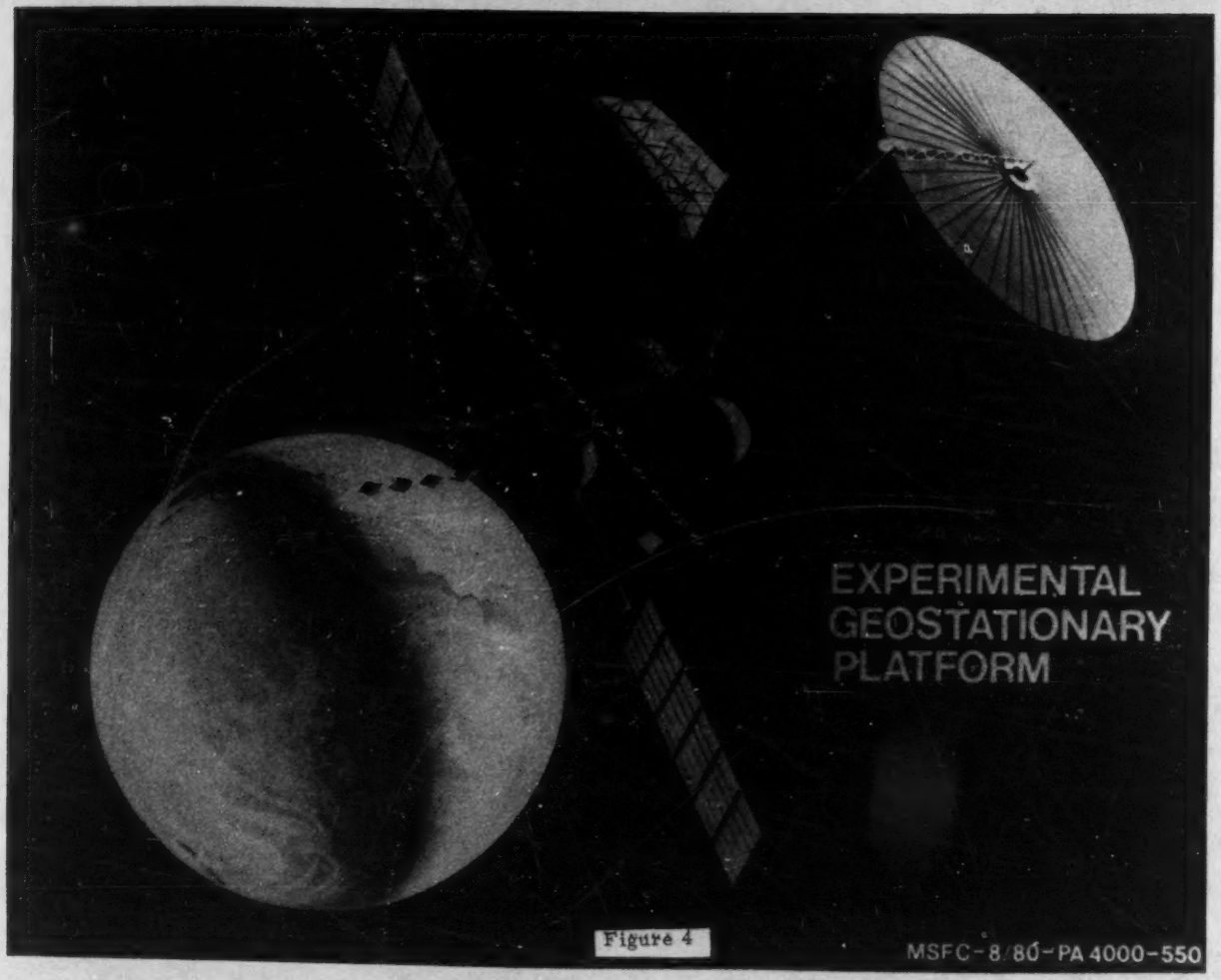
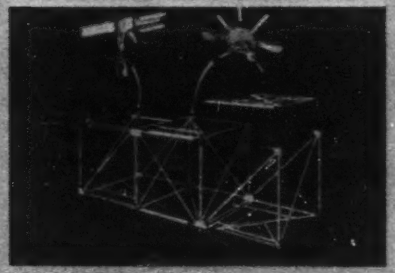


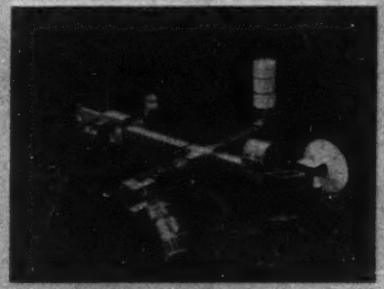
Figure 4

LARGE SPACE STRUCTURES

DEPLOYABLE TRUSS GROUND TEST



TRUSS APPLICATIONS ON SPACE PLATFORM



LSS ASSY. TESTS

DEPLOYABLE MAST APPLICATIONS

SOLAR ARRAY FLT. TEST

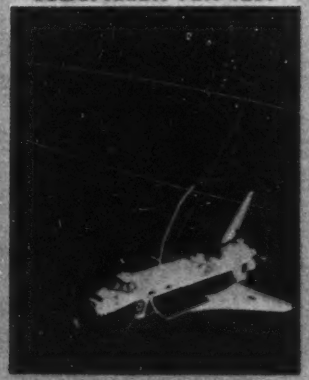


Figure 5

LARGE SPACE STRUCTURES

DEPLOYABLE ANTENNA FLIGHT EXPERIMENT

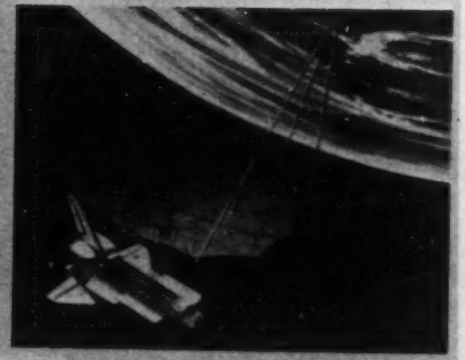


Figure 6

Figure 7

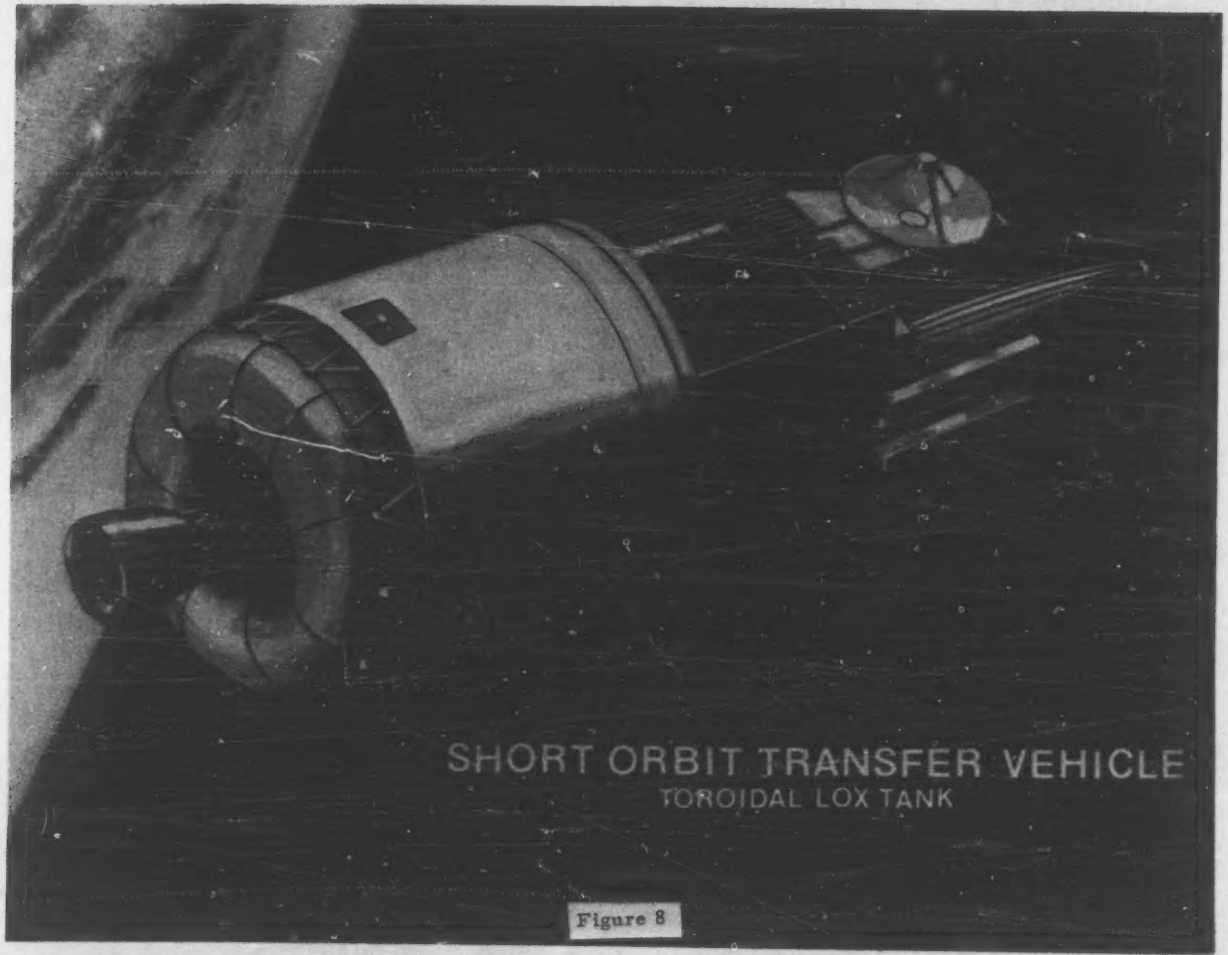


Figure 8

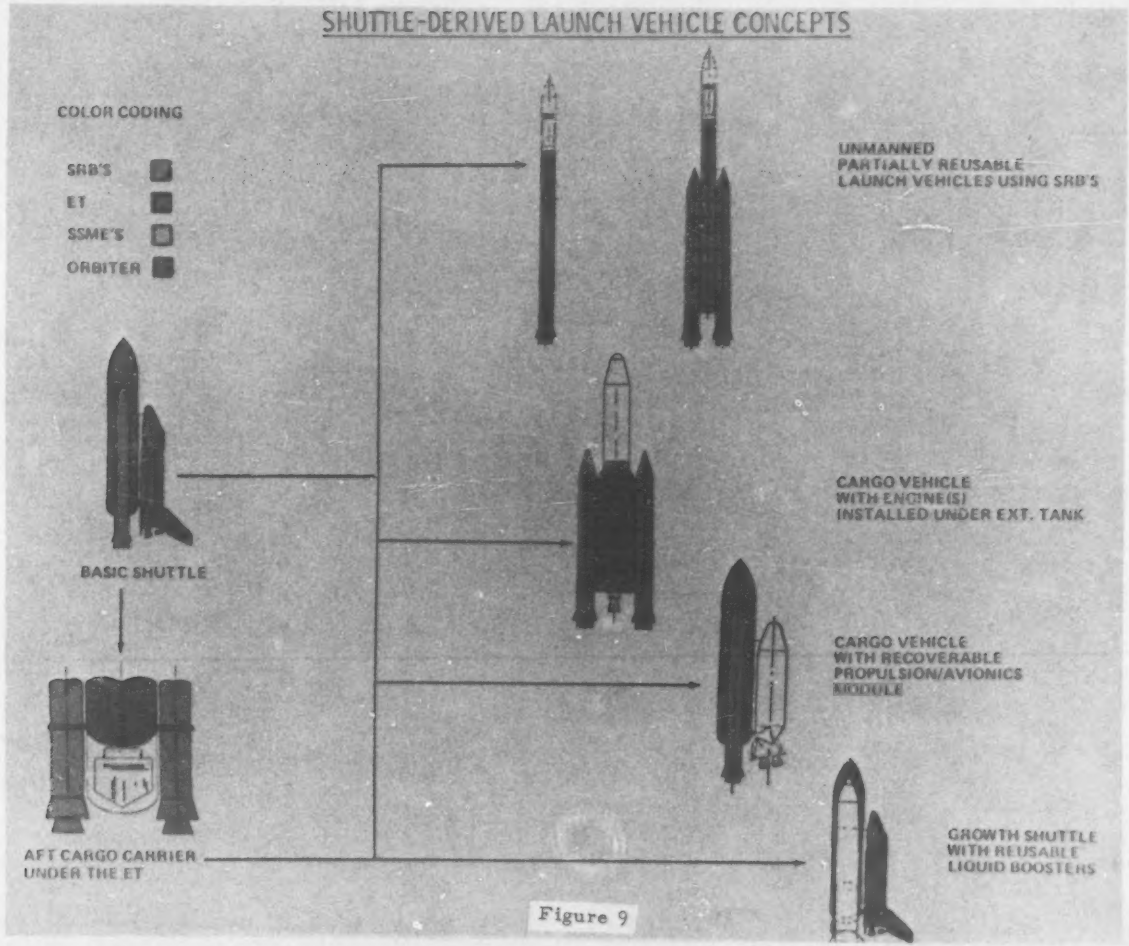

SHUTTLE-DERIVED LAUNCH VEHICLE CONCEPTS
COLOR CODING
SRB'S
ET
SSME'S
ORBITER
UNMANNED
PARTIALLY REUSABLE
LAUNCH VEHICLES USING SRB'S
CARGO VEHICLE
WITH ENGINE(S)
INSTALLED UNDER EXT. TANK
BASIC SHUTTLE
CARGO VEHICLE
WITH RECOVERABLE
PROPULSION/AVIONICS
MODULE
AFT CARGO CARRIER
UNDER THE ET
GROWTH SHUTTLE
WITH REUSABLE
LIQUID BOOSTERS

Figure 9

Figure 10

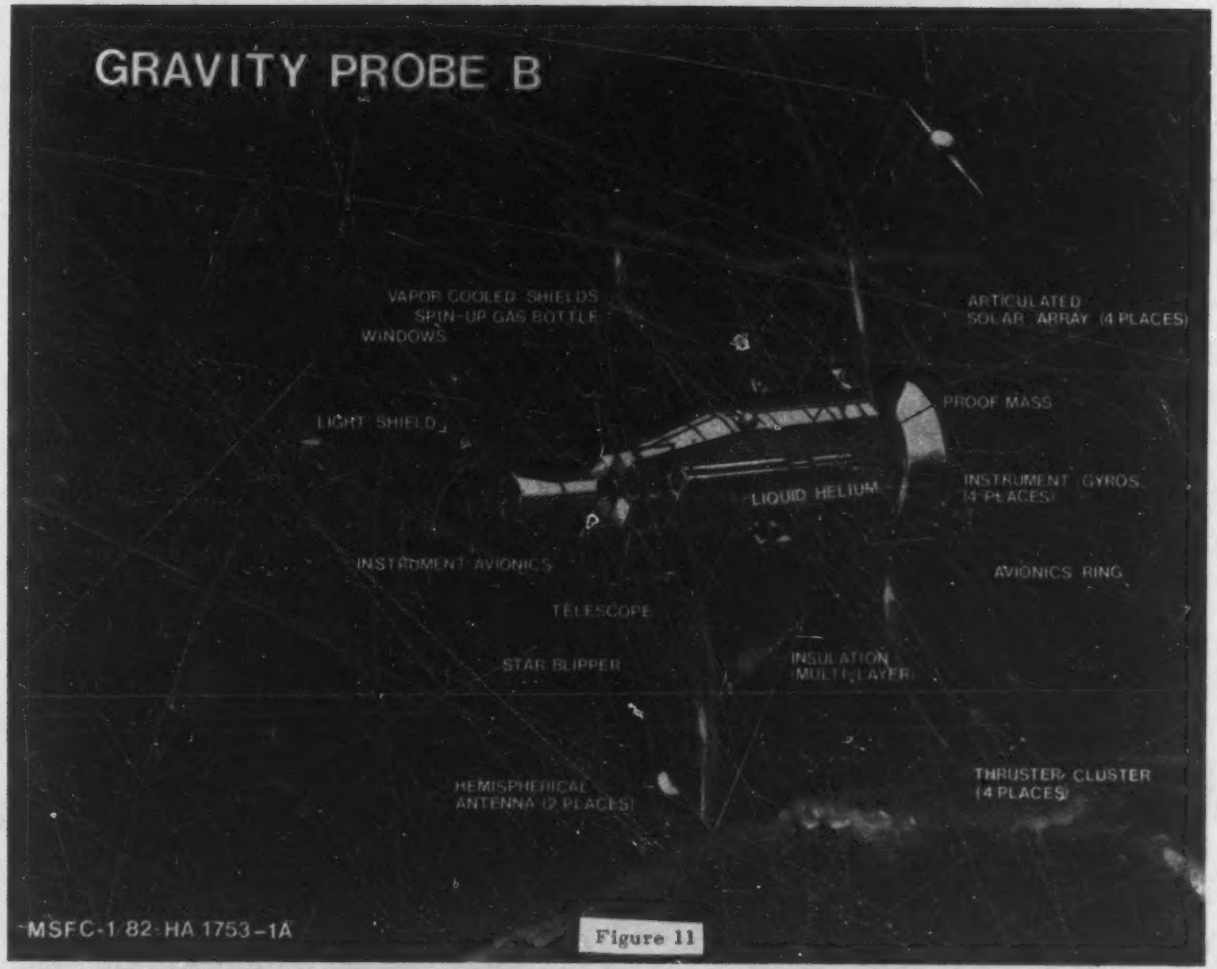

GRAVITY PROBE B
VAPOR COOLED SHIELDS
SPIN-UP GAS BOTTLE
WINDOWS
ARTICULATED
SOLAR ARRAY (4 PLACES)
PROOF MASS
LIGHT SHIELD
LIQUID HELIUM
INSTRUMENT GYROS
(4 PLACES)
INSTRUMENT AVIONICS
AVIONICS RING
TELESCOPE
STAR SLIPPER
INSULATION
(MULTI-LAYER)
HEMISPHERICAL
ANTENNA (2 PLACES)
THRUSTER CLUSTER
(4 PLACES)
MSFC-1 82-HA 1753-1A

Figure 11

Figure 12

Figure 13

SHUTTLE TIME AND FREQUENCY
TRANSFER EXPERIMENT

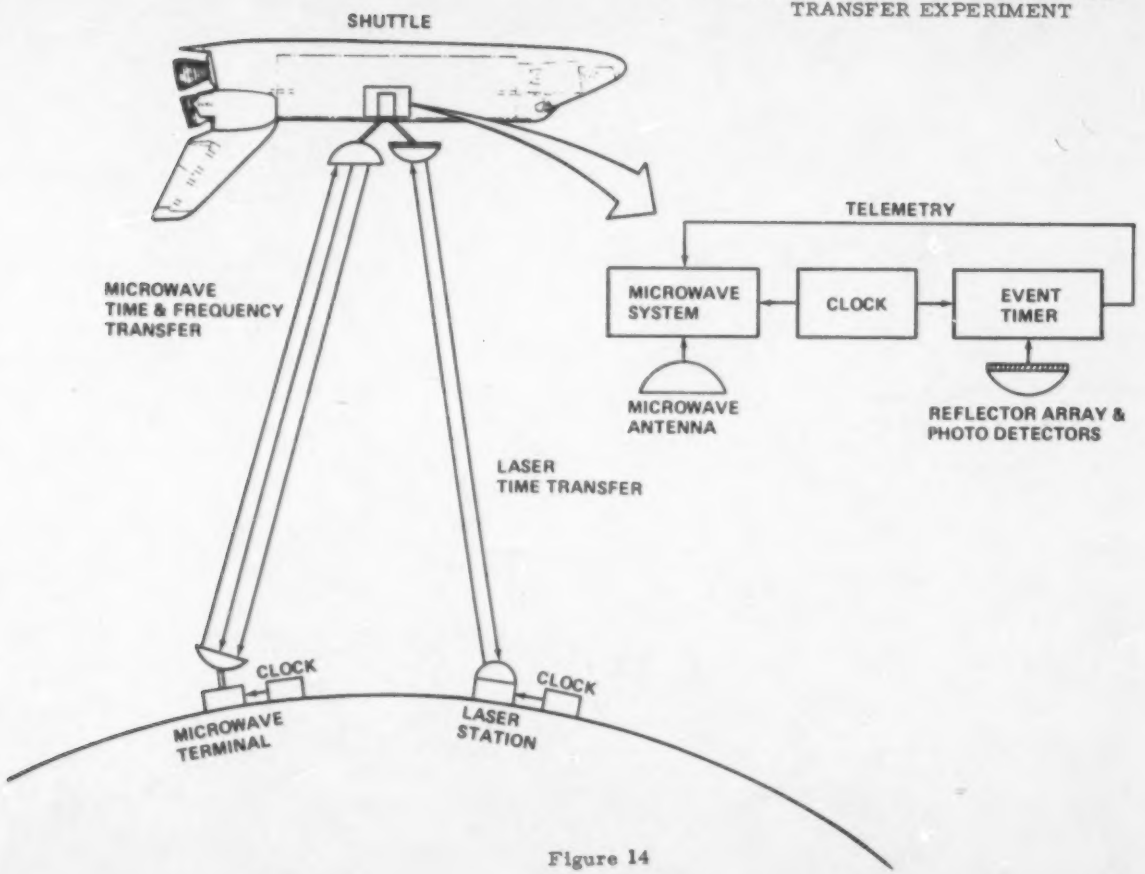


Figure 14

February 12, 1982

STATEMENT

of

MR. JOHN W. THOMAS
MANAGER, SPACELAB PROGRAM

MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

for the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

Spacelab is an international cooperative program between NASA and the European Space Agency (ESA) that is being developed as a key element of the Space Transportation System. Figure 1 depicts the modular Spacelab. Carried in the Shuttle Orbiter bay, it provides manned laboratory modules (with shirt-sleeve environment) and/or unpressurized instrument pallets suitable for conducting research and applications activities on Shuttle sortie missions. Intended to complement the economics of the reusability of the Space Shuttle, Spacelab has a design life of ten years, minimum, and for at least 50 missions.

Under the NASA/ESA Memorandum of Understanding, NASA is responsible for overall program planning and management, development of selected hardware and software, follow-on procurement, and operations. ESA is responsible for design and development of the module and pallets with their associated support equipment, delivery to NASA of specified hardware, limited post-development engineering support, and production of NASA-procured Spacelab hardware.

In preceding reports to the Subcommittee, it was noted that the ESA Spacelab Program had advanced to the point that: (1) the Spacelab Engineering Model (EM) and major elements of the Mechanical Ground Support Equipment (MGSE) had been accepted by NASA and transported to

KSC in good condition; (2) activities under the follow-on procurement contract had proceeded satisfactorily since authorization to proceed was given in January 1980, such that materials had been received and fabrication had been initiated on all subsystems, except the Instrument Pointing System (IPS)--fabrication for the IPS had been delayed pending the results of a Critical Design Review of the redesigned system; (3) completion of the software operating systems had been accomplished by ESA/NASA; (4) NASA and ESA had negotiated a Post Delivery Change Control for the first two Spacelab missions; and (5) early acceptance of Spacelab flight unit hardware to support the SPICE (Spacelab Payload Integration and Coordination in Europe) experiment integration and checkout had been completed.

NASA achievements previously reported included: (1) operational activation of the Software Development Facility; (2) completion of the Critical Design Review (CDR) for the Spacelab Mission 1 software; (3) completion of CDR's for the Verification Flight Instrumentation (VFI) for Spacelab Missions 1 and 2; (4) completion of the Spacelab Transfer Tunnel CDR; and (5) completion of the Spacelab Window Adapter Assembly CDR.

Review of 1981 Progress

Of major significance in 1981 was NASA's final acceptance from ESA of the initial Spacelab flight hardware (module, two pallets, and ground support equipment). The acceptance review was conducted in Europe by a group of ESA and NASA management officials and technical representatives with the primary objective of assuring that the elements conformed to approved design and performance requirements.

Following acceptance by NASA, the hardware was delivered to the Kennedy Space Center without incident from ERNO on December 11, 1981, aboard a USAF C-5A Galaxy Aircraft. (Figure 2 shows the hardware being offloaded at KSC.)

Other major Spacelab equipment deliveries in the past year included: (1) Spacelab Electrical Ground Support Equipment (EGSE) and Mechanical Ground Support Equipment (MGSE) delivered in July 1981; and (2) Spacelab flight hardware—experiment racks together with their handling/transport kits, and two unit testers—were delivered in November.

The Spacelab Orbital Flight Test (OFT) pallet system was successfully flown on STS-2, providing full support to the Office of Space and Technology Applications-1 (OSTA-1) payload. A second OFT pallet system and its payload, shown in Figure 3, and designated as Office of Space Science-1 (OSS-1) payload, has undergone installation and checkout in the Orbiter for flight on STS-3 in March 1982.

The hardware accepted for Spacelab Payload Integration and Coordination in Europe (SPICE) was configured to SPICE requirements, and the European experiments have been integrated with the Spacelab hardware; and checkout is in process. The integrated package will be transported to NASA early this year to be integrated with the remainder of the Spacelab Mission 1 payload.

The Spacelab Transfer Tunnel, shown in Figure 4, is a major item of hardware provided by NASA. The tunnel provides for a "shirt-sleeve" transfer of crew members between the Orbiter cabin and the Spacelab module. The non-metallic flexible sections of the Tunnel are provided by Goodyear Aerospace Corporation. The manufacture of the metallic "Hard Sections" and final assembly and test will be accomplished at McDonnell Douglas Astronautics Company-West (MDAC-W) in Huntington Beach, California. Fabrication and delivery of the flexible sections were completed this year. Manufacture of the Hard Sections was initiated in 1981 and is still in process.

The Spacelab Window Adapter Assembly (SWAA) is another item of NASA-supplied equipment. It consists of an adapter plate containing a high quality window flown on Skylab and an ESA-provided viewport as shown in Figure 1. The high quality window was initially procured as a spare window for the Skylab Program and will be requalified for the Spacelab environment as a part of the assembly. The SWAA basic design effort has been completed and component fabrication will begin in March 1982.

The development of all software operating systems required for the first flight has been completed and accepted by NASA. Installation of these systems on the NASA facilities is proceeding on schedule. The NASA Spacelab-1 Experiment Computer Application Software, the software unique to each experiment, has recently been completed and will now undergo verification testing. The preliminary version of the SPICE application software for the European experiments has also been received. The final version is due in March 1982.

During 1981, ESA undertook redesign of the Instrument Pointing System to assure adequate load margins, and MSFC conducted a successful Preliminary Design Review (PDR) of the redesign. The PDR primarily involved the determination as to whether the redesign specifications/requirements had been properly understood and incorporated into the design documentation. The review revealed that basically all inadequacies identified in previous reviews were resolved in the redesign. The Critical Design Review for the redesigned unit is scheduled for early 1982.

Future Outlook

During the next several months, the Spacelab Development Program will continue to require major efforts. Activities required for the launch

of Spacelab Missions 1 and 2 will become increasingly demanding, as will planning and preparation for the operational era. Timely achievement of these requirements will present a strong challenge to responsible individuals and organizations alike. The following examples of activities to be performed in the near term provide some insight into what is ahead.

The subsystem checkout is presently underway on the Spacelab pallet-only mode flight hardware, which is an igloo and pallet configuration, in Europe. This test is intended to evaluate the functions and operation of each of the subsystems. Final integration and test of this configuration is presently scheduled for April 1982. Following completion of the test program and a successful acceptance review, this Spacelab and the second set of ground support equipment will be shipped to the United States.

Within the next year the various software packages will be finalized and integrated into a single flight tape for the first Spacelab flight. The development of Spacelab-2 experiment software and the development of software necessary for the experiments to use the IPS will be underway.

Fabrication of the Spacelab Transfer Tunnel qualification test unit and flight unit will be completed in 1982. Upon successful completion of acceptance tests and reviews, the flight unit will be delivered to NASA at Kennedy Space Center in January 1983.

The Spacelab-1 Cargo Integration Review (CIR) will be held in June 1982. The CIR is a formal review of cargo, mission, basic operations and engineering interface compatibility of the payload and the Space Transportation System (STS). It will provide the assurance that the payload requirements can be physically and functionally integrated into STS flight and ground capabilities.

The Spacelab Design Certification Review (DCR) is scheduled for the fall of 1982. The review will enable NASA to verify that the Spacelab hardware and software will support the intended application, and that they are certified for flight worthiness and manned safety.

Spacelab Flight Unit 1 is at Kennedy Space Center undergoing receiving inspection. The electrical ground support equipment, which was shipped with the flight module and pallet, will be verified with the Engineering Model prior to its use on the flight unit. Prior to arrival of Flight Unit 2 this summer, verification of the Flight Unit 1 subsystem will be in process.

The Spacelab Follow-On Production (FOP) is proceeding well, and initial deliveries of hardware will begin this year. The delivery of two pallets in late summer will constitute the first major hardware elements.

Spacelab launch dates have been adjusted since the last report to the Subcommittee in accordance with changes in the Shuttle flight schedule. Consequently, Spacelab Missions 1 and 2 are now expected to be launched in September 1983 and November 1984 respectively.

In summary, the past year has been both a busy and eventful one for the Spacelab Program. The first Spacelab flight hardware has been accepted by NASA and delivered to the Kennedy Space Center. The OSTA-1 OFT Pallet System was successfully flown on STS-2. Realtime mission support was provided through the Huntsville Operational Support Center (HOSC). The OSS-1 OFT Pallet pre-integration review and installation in the Orbiter for the STS-3 flight have been completed. The Spacelab Electrical Ground Support Equipment (EGSE) and servicers have been validated to support operation of the Engineering Model for EGSE and facility validation. The assembly of Spacelab-1 flight hardware at the Kennedy Space Center and the performance of system level tests are proceeding as planned.

[Figures 1-4 of Mr. Thomas' prepared statement follow:]

LOW EARTH ORBIT
DOPPLER LIDAR
SCAN PATTERN
MSFC-4/81-PA 4000-559B

Figure 15

93-418 O—82—38

Figure 16

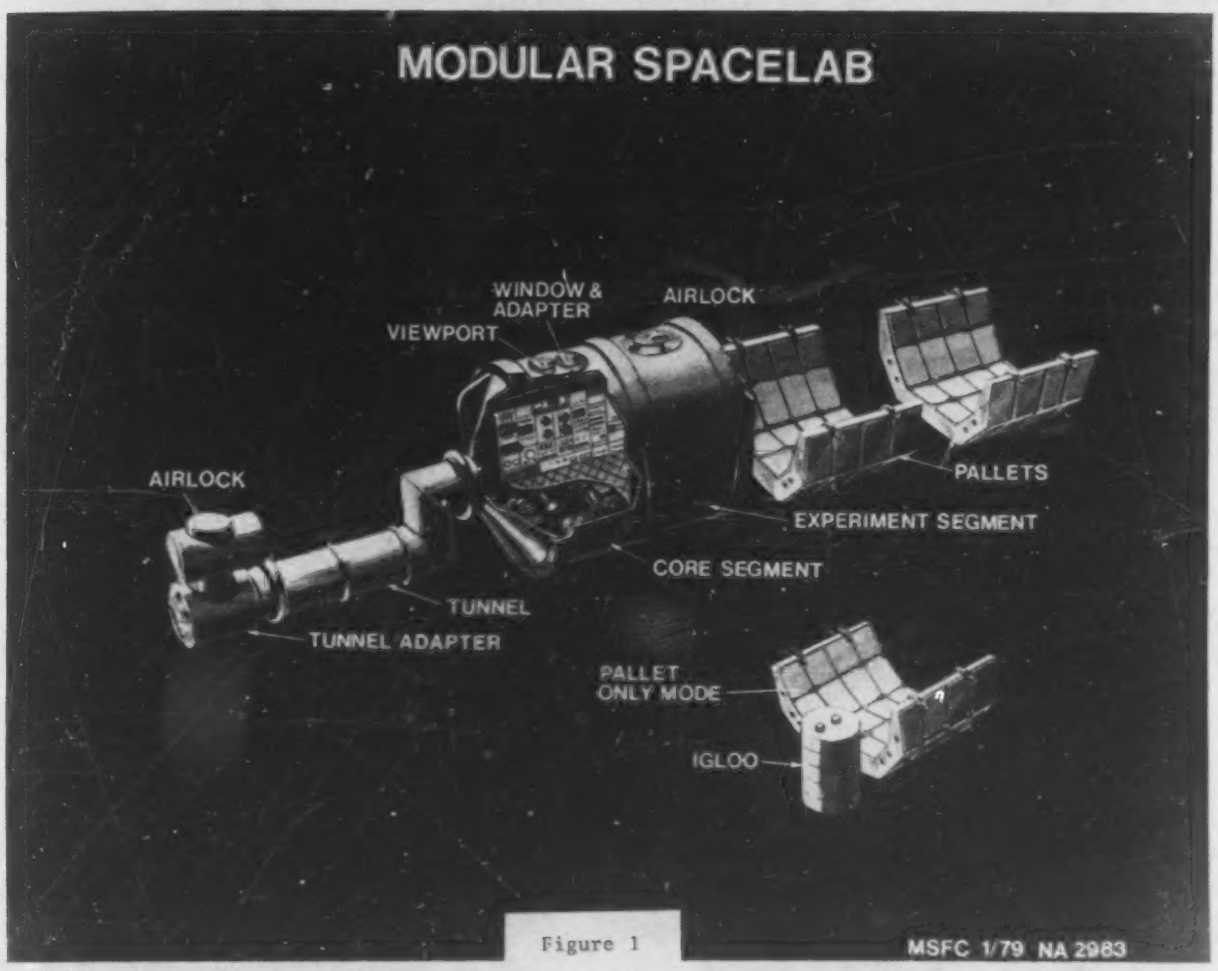

MODULAR SPACELAB
WINDOW & ADAPTER
VIEWPORT
AIRLOCK
AIRLOCK
PALLETS
EXPERIMENT SEGMENT
CORE SEGMENT
TUNNEL
TUNNEL ADAPTER
PALLET ONLY MODE
IGLOO
MSFC 1/79 NA 2983

Figure 1

INITIAL SPACELAB FLIGHT HARDWARE (MODULES, 2 PALLETS) UNLOADING AT KSC.

Figure 2

February 12, 1982

STATEMENT

of

MR. JAMES A. DOWNEY III
MANAGER, SPACELAB PAYLOAD PROJECT OFFICE
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

on

SPACELAB PAYLOAD PROJECTS

for the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

This statement provides an overview of Marshall Space Flight Center's (MSFC) Spacelab mission payload assignments. The term mission, as used in this statement, includes all activities associated with the payload, but does not include the basic Space Transportation System (STS) support.

MSFC has responsibility for Spacelab Mission 1, Spacelab Mission 2, and Spacelab Mission 3, as well as certain partial payloads for future Space Shuttle missions. These partial payload mission assignments include the Monodisperse Latex Reactor (MLR), Office of Space and Terrestrial Applications-2 (OSTA-2), Office of Aeronautics and Space Technology-1 (OAST-1), Materials Experiment Assembly-1 (MEA-1), and the recently assigned responsibilities for the Office of Space Science-3 (OSS-3) mission in support of Goddard Space Flight Center (GSFC). Mission Managers have been designated within the Spacelab Payload Project Office to manage the implementation of these MSFC assignments.

MISSION MANAGEMENT ROLE

The basic function of the mission management team is to represent the payload user community in the utilization of the STS by providing an interface between the payload

cargo requirements, operational capabilities, and safety requirements of the STS. This relieves the users of the need to resolve the complexities of payload-to-Spacelab interface problems allowing them to concentrate on development of their experiments. The Mission Manager negotiates STS services for the users and assists them in meeting the scientific and applications objectives in the most economical manner.

The Mission Manager has complete responsibility for all aspects of the mission as illustrated in Figure 1. This includes the budget for integration activities, interfaces between mission elements, schedules for mission implementation, planning integration activities, and real-time execution of the mission in conjunction with the Mission Control Center operation of the Space Shuttle.

MISSION ASSIGNMENTS AND STATUS

The missions and partial payloads currently assigned to MSFC for implementation are listed on the summary schedule (Figure 2), which depicts the major milestones leading to launch. These assignments are discussed below, including a brief description of the status and accomplishments during the past year. The objectives of these missions have not changed since the last statement to the Subcommittee in March 1981 and are not described in detail in this statement.

The objectives of Spacelab Mission 1, a joint National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) mission, are basically to test the Spacelab systems and demonstrate the research capability of Spacelab. The current manifested launch date for this mission is September 1983.

Spacelab Mission 1 is a long, pressurized module and pallet configuration as illustrated in Figure 3. The payload complement consists of Verification Flight Instrumentation (VFI) and NASA and ESA experiments and facilities in the following disciplines: Atmospheric Physics, Plasma Physics, Solar Physics, Astronomy, Life Sciences, Material Science, Earth Observations and Technology. The experiment and required mission hardware deliveries are on schedule, and payload specialist training is progressing as planned. Major accomplishments during the past year include delivery of Spacelab hardware to ESA to start physical integration. Approximately 95 percent of ESA experiments have been integrated and approximately 80 percent of NASA experiments are ready to start physical integration.

Spacelab Mission 2 objectives are essentially the same as Spacelab Mission 1, but will test a different complement of hardware. The launch date for Spacelab 2 is November 1984.

Spacelab Mission 2 is a pallet only (three pallets and a special support structure) configuration as shown in Figure 4. The payload complement consists of 12 experiments in the following disciplines: Life Sciences, Plasma Physics, Astronomy, High Energy Physics, Solar Physics, Atmospheric Physics, and Technology. Experiment and mission equipment design and development activities, and payload specialist training are progressing on schedule. Accomplishments during the past year include completion of the design on the major mission unique equipment.

Spacelab Mission 3 is the first "operational" Spacelab mission, and the objectives are essentially to conduct applications, scientific, and technology experiments in orbit. The current launch readiness date for Spacelab 3 is August 1984. The launch date specified in the last statement to the Subcommittee was April 1984.

The Spacelab Mission 3 configuration consists of a long, pressurized module and a mission unique equipment support structure as shown in Figure 5. The planned payload consists of multidisciplinary experiments and facilities in the following disciplines: Materials Processing, Life Sciences, Environmental Observations, Astrophysics, and Technology. The payload and mission unique equipment development activities and analytical integration activities are progressing on schedule. Accomplishments during the past year include the completion of qualification testing of the fluid loop pump assembly, a major piece of mission unique equipment.

The initial MLR is now scheduled for launch on STS-3 in March 1982 with launches planned on three other future STS flights. The MLR will be mounted in the Orbiter mid-deck as shown in Figure 6. The objectives are basically to study kinetics of MLR chemical reactions in a low gravity environment. The flight hardware has been delivered to the Kennedy Space Center (KSC) for installation into the Orbiter followed by testing.

The OSTA-2 partial payload (Figure 7) is a cooperative NASA/Republic of West Germany mission to conduct materials processing experiments in orbit. The current manifested launch date is April 1983. During the past year, the final design and operations review was conducted on the payload and modal survey testing was initiated on

the special support structure. The experiment and integration hardware development is on schedule.

The OAST-1 partial payload (Figure 8) objectives are basically to conduct solar array and large structures technology investigations in Earth orbit. The current manifested launch date is April 1984. Elements of the payload and integration hardware are nearing completion.

The MEA-1 partial payload (Figure 9) objectives are to conduct materials processing experiments in low gravity. The current manifested launch date is April 1984. The MEA-1 payload is similar to OSTA-2. Guidelines for experiment selection have been developed.

Responsibility for analytical integration support to Goddard Space Flight Center for the OSS-3 mission was assigned to MSFC in December 1981. Initial planning is now in progress in preparation for launch in February 1985. The objectives of the OSS-3 mission are to conduct astronomical observations of the stars, galactic nuclei and quasars using ultraviolet telescopes. The OSS-3 configuration will consist of two Spacelab pallets with an igloo. The planned payload consists of three ultraviolet telescopes mounted on the MSFC-developed Advanced Gimbal System (AGS).

FUTURE ACTIVITIES

The 1982 activities include continuation of planning and definition of payload integration requirements for assigned missions and partial payloads; design and development of experiments and mission unique equipment; continuation of payload specialist training; and providing physical integration support to KSC.

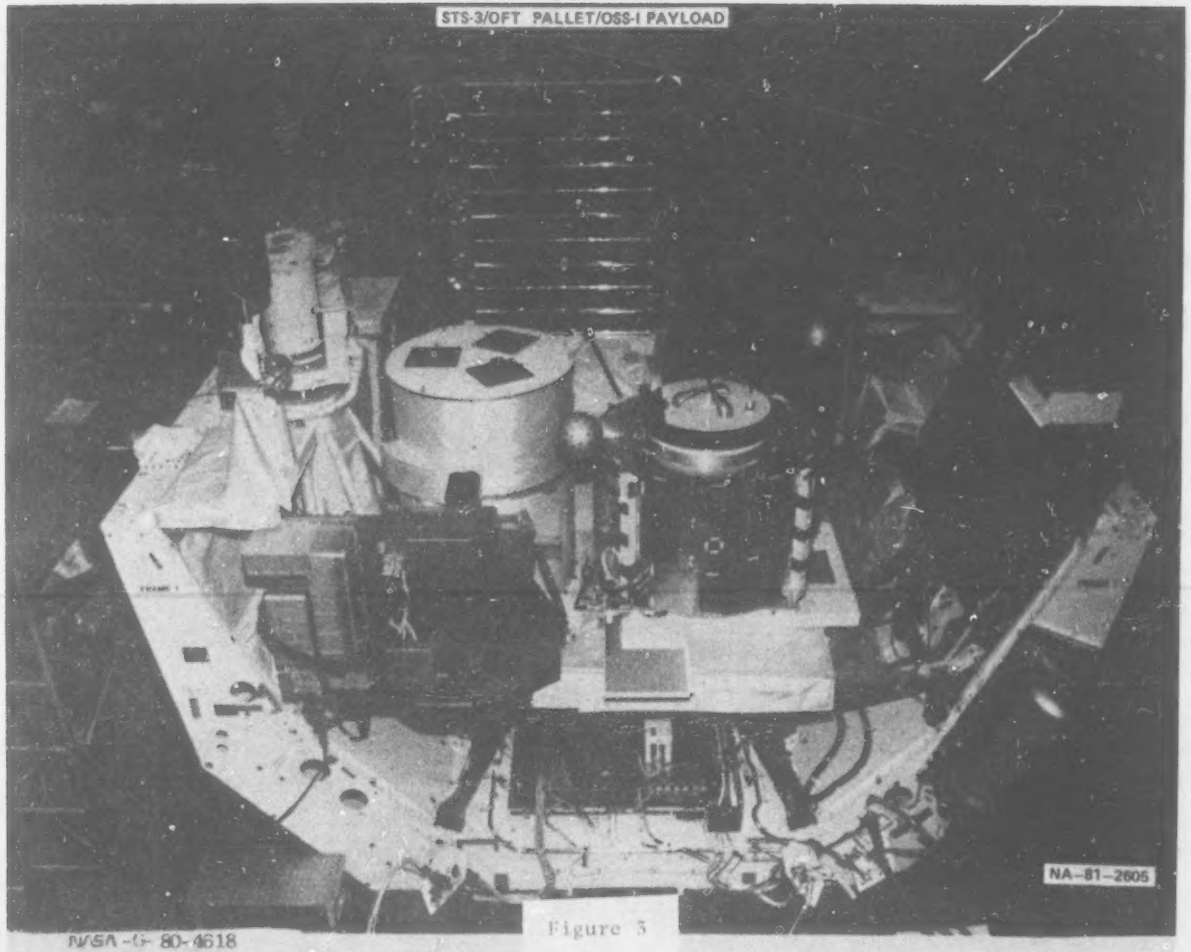
During 1982, Spacelab Mission 1 payload physical integration will be completed, payload integration with the Spacelab hardware will be initiated, payload specialist training will be continued, and the flight software delivered to KSC.

Spacelab Mission 2 planned activities in 1982 include continuation of experiment hardware development and payload specialist training. The ground integration requirements will be baselined and the flight operations review conducted.

Spacelab Mission 3 planned activities in 1982 include continuation of analytical integration leading to completion of the integrated payload final design and operations review.

The MLR will be launched in March 1982 on STS-3 and mission integration activities will be initiated in preparation for the next MLR flight. Mission implementation activities will also proceed in 1982 leading to launch of OSTA-2 in April 1983, and launch of MEA-1 and OAST-1 partial payloads in April 1984. The MEA-1 and OAST-1 requirements reviews and initial design evaluations will be accomplished in 1982. The tasks planned for 1982 in support of the OSS-3 mission include establishing a baseline configuration, initiation of analytical integration activities, and completion of the initial design evaluation.

[Figures 1-9 of Mr. Downey's prepared statement follow:]



NASA-S-80-4618

Figure 3

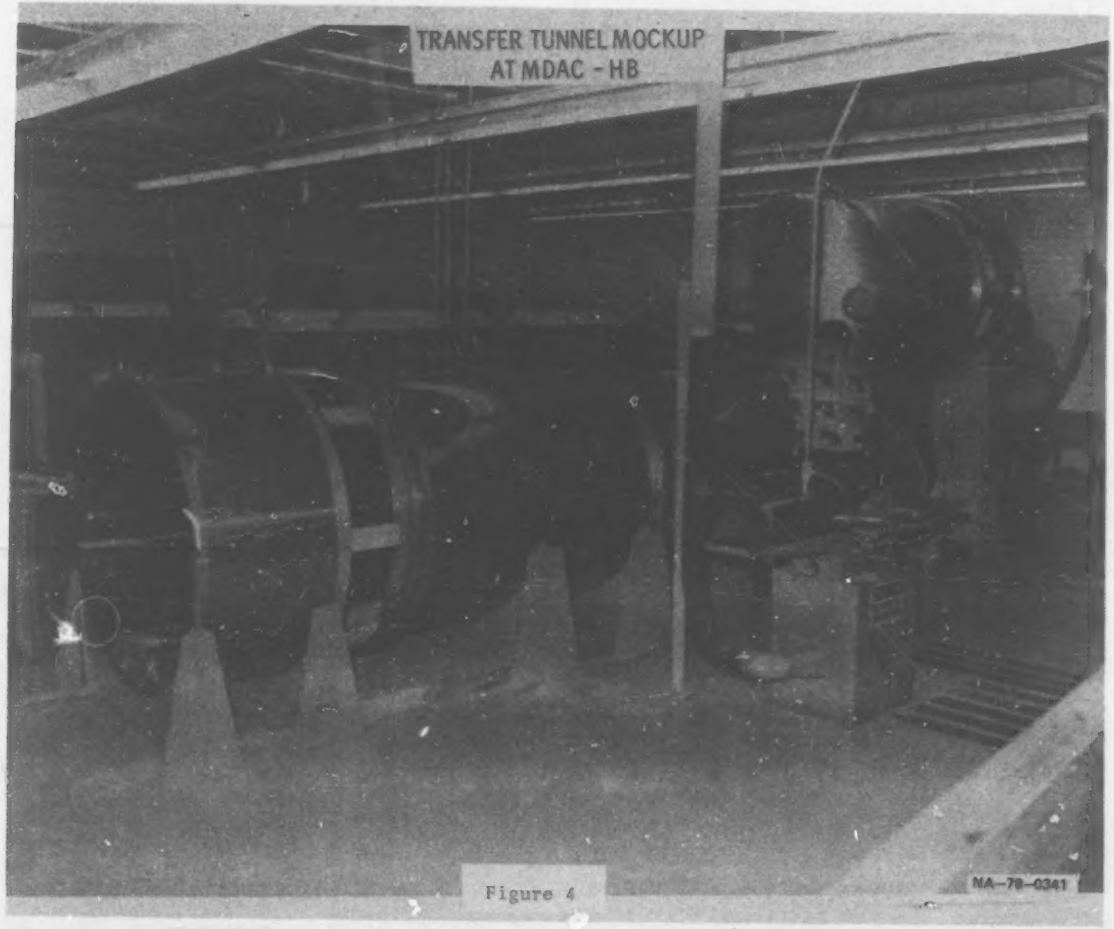


Figure 4

FIGURE 15

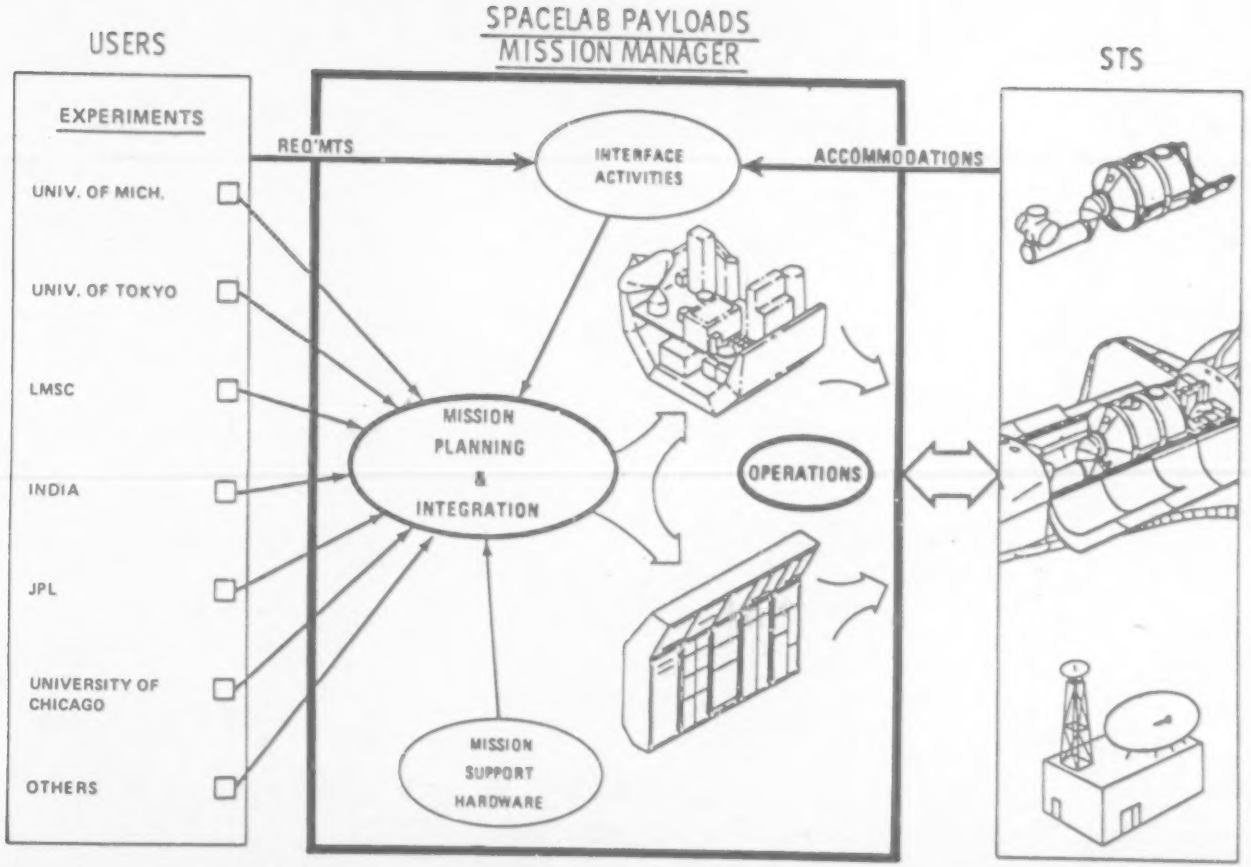


FIGURE 1

SPACELAB PAYLOAD MISSIONS SUMMARY SCHEDULE

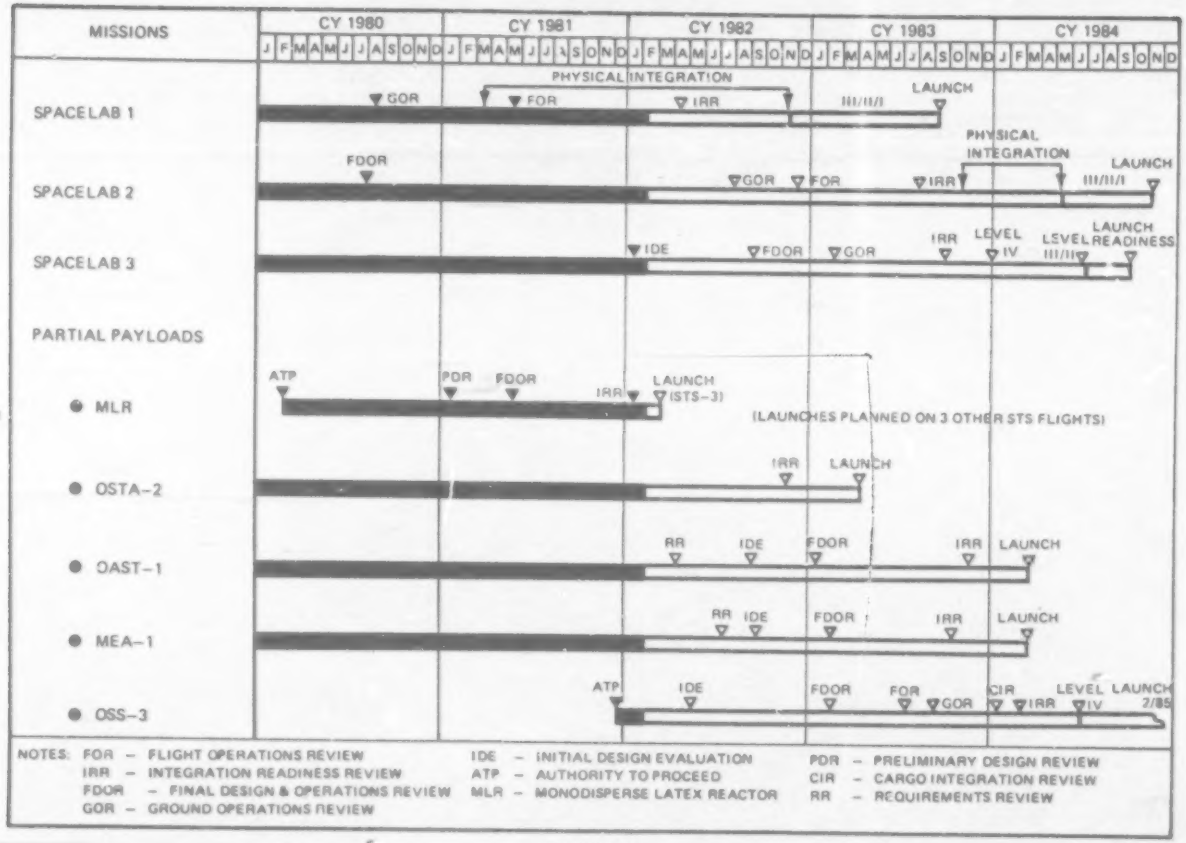


FIGURE 2

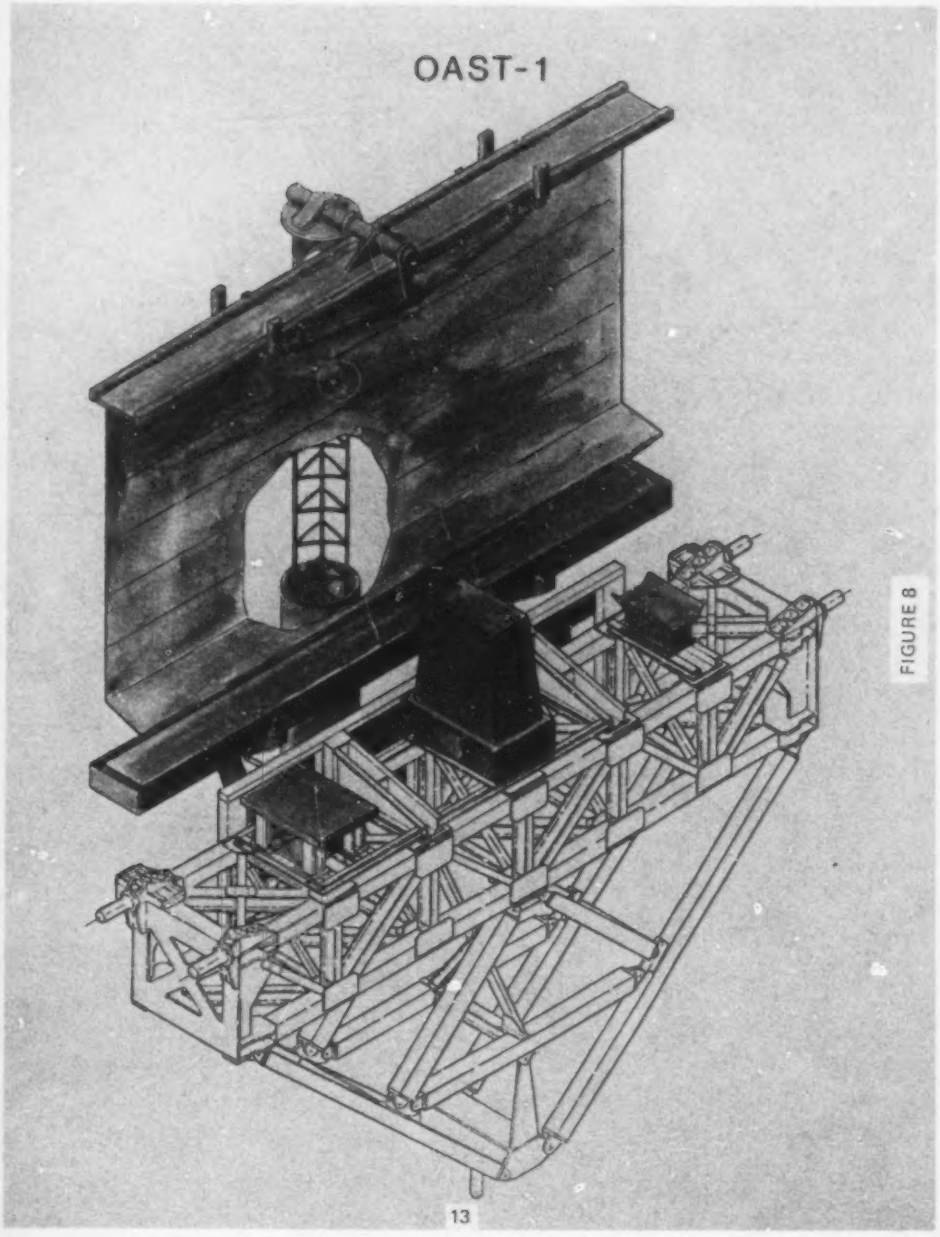


FIGURE 8

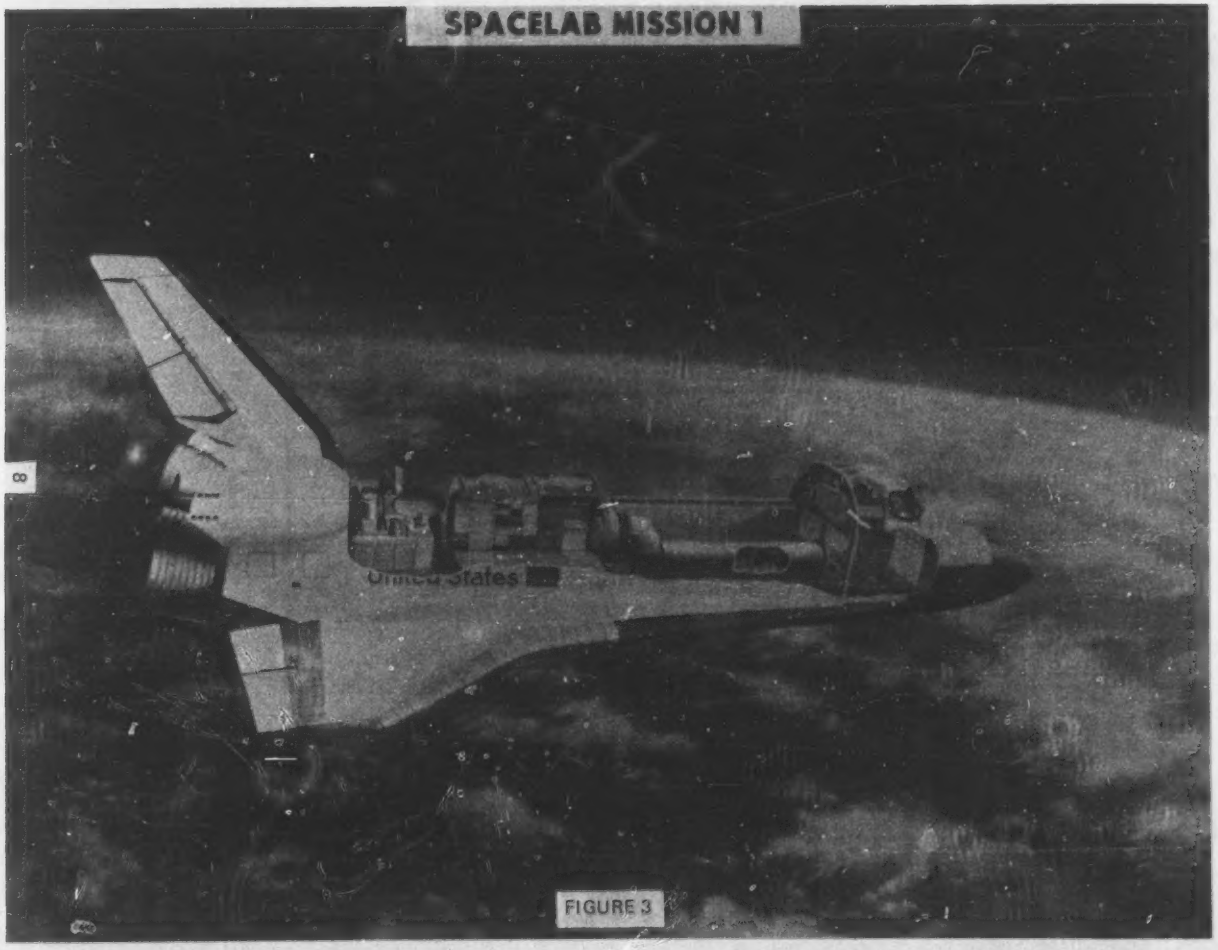


FIGURE 3

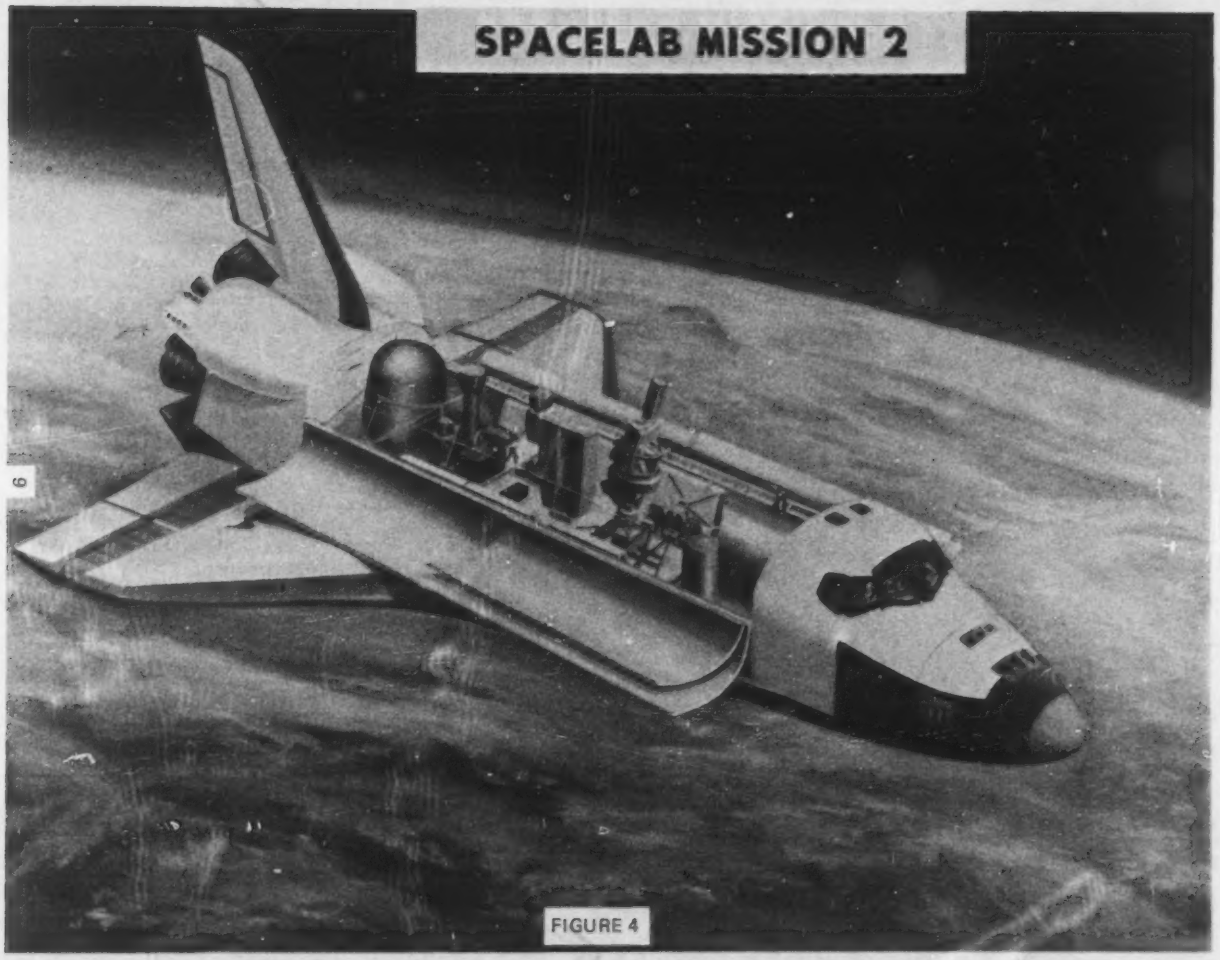


FIGURE 4

SPACELAB MISSION 3

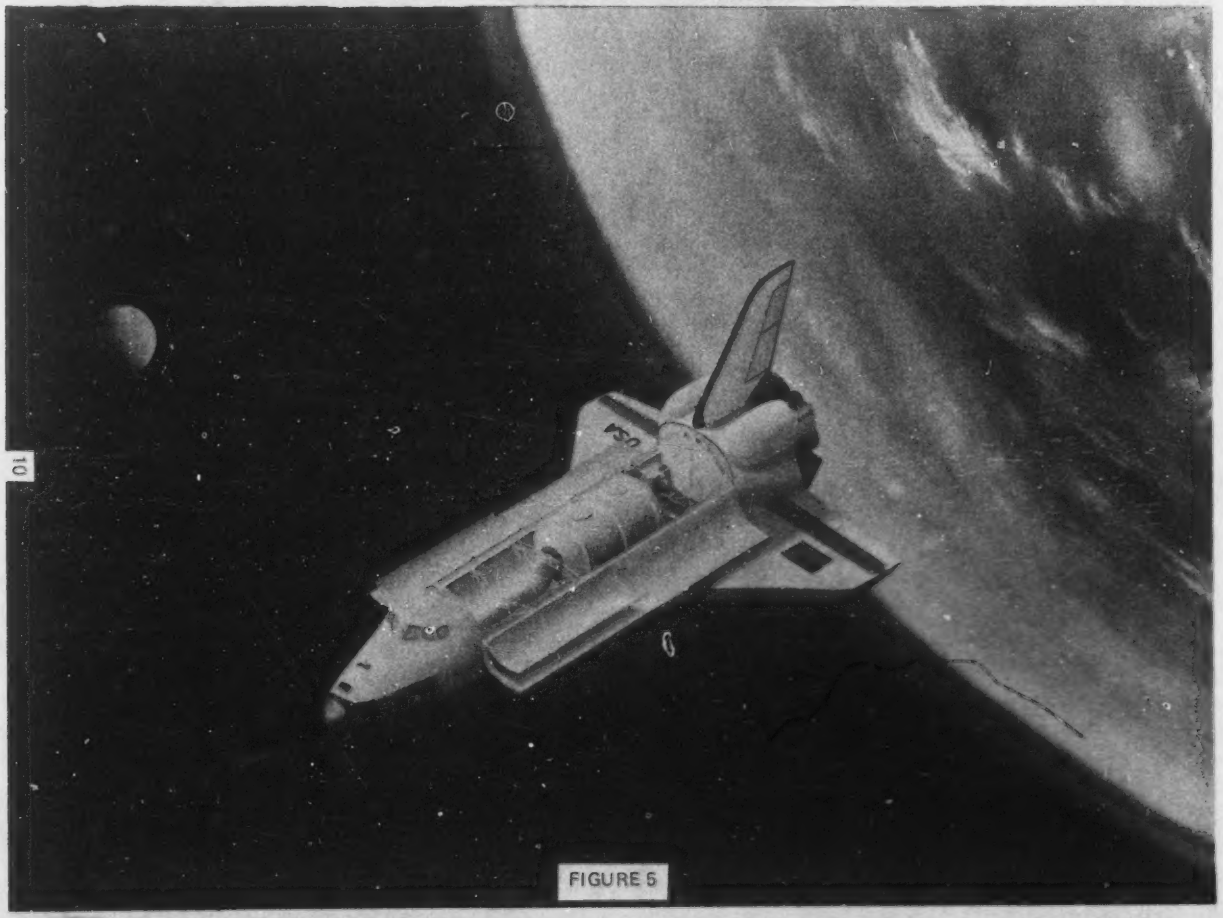


FIGURE 5

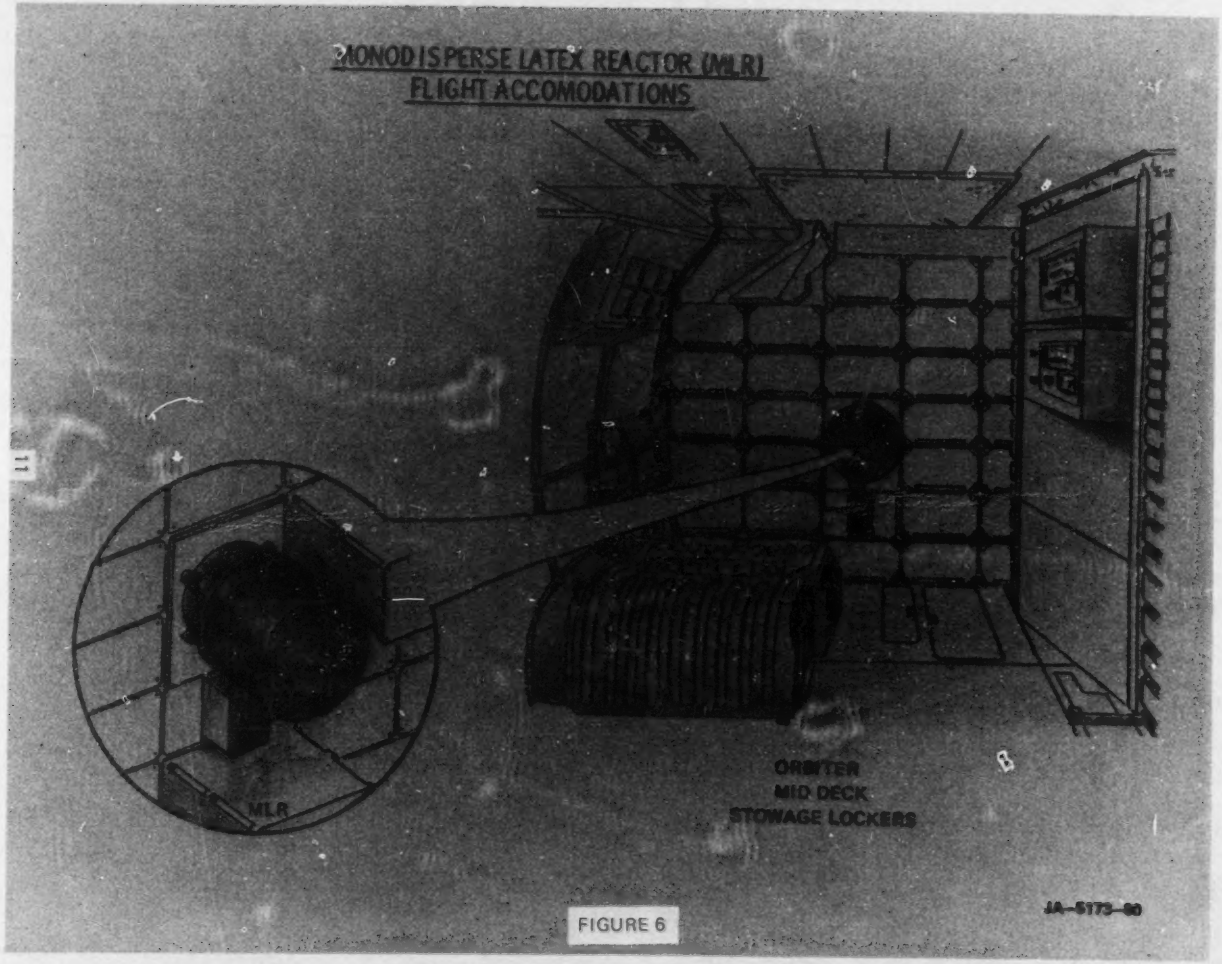

MONODISPERSE LATEX REACTOR (MLR)
FLIGHT ACCOMODATIONS
MLR
ORBITER
MID DECK
STOWAGE LOCKERS
A
B
JA-5173-90

FIGURE 6

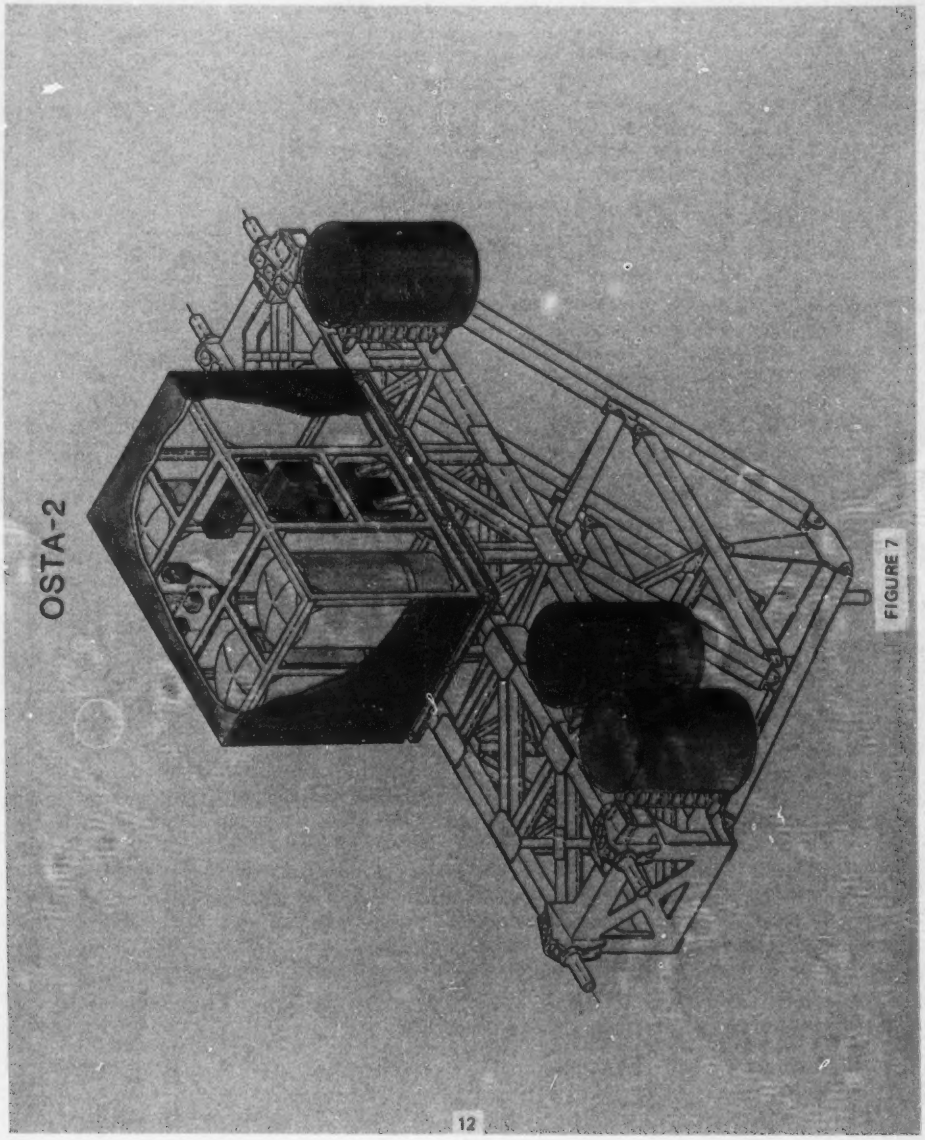


FIGURE 7

February 12, 1982

STATEMENT

of

MR. LOWELL K. ZOLLER
MANAGER, MATERIALS PROCESSING IN SPACE PROJECTS OFFICE
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

on

MATERIALS PROCESSING IN SPACE PROJECTS

for the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

The goal of the Materials Processing in Space (MPS) program is to sponsor the basic research to isolate the gravitational effects that occur during the production of common materials in order to promote private sector initiative in applied research and commercialization. During this year, tangible, but cautious, steps have been taken toward commercialization. There has been an expanding involvement with industry through various levels of commitment to ground based and space borne applied research. Mutually beneficial research partnerships (referred to as Technical Exchange Agreements and Industrial Guest Investigations) have been implemented with Deere and Company, Bethlehem Steel, INCO, DuPont and TRW. These ventures entail the utilization of NASA facilities and consultation to further company sponsored applied research in much the same way as the government's extensive wind tunnel facilities constitute a national resource. Applied research is being pursued in the general areas of graphite management in cast iron, structural formation of coke, "immiscible alloys" (i.e., uniform dispersions of two or more materials that do not mix in 1-g), catalysts, and directionalized crystal growth. Use has been made of existing free fall facilities at the Marshall Space Flight Center, NASA aircraft, and sounding rockets to achieve brief periods of 0-g for industrial experimentation time shared with NASA sponsored research activities.

More extensive private sector commitments have been made for experiments to be flown on the Space Shuttle. Previously reported, McDonnell Douglas Astronautics and Johnson & Johnson Pharmaceutical are engaged in an extensive precommercialization effort for separation of biological materials in space where the absence of gravity greatly facilitates both the purity of the separation and the quantity of separated materials. Extensive progress has been made during the past year in the development of the experimental hardware which has been built and qualified for flight on STS-4 (Figure 1). In parallel, ground based research on the pharmaceutical candidates is being advanced in its many facets. As part of the agreement, biological samples are to be separated for NASA to further its research programs and technology base relative to electrophoretic processes; therefore, inhouse effort has resulted in the selection and preparation of samples for the initial experiments.

A second joint endeavor has been formalized with GTI Corporation of San Diego, California, to develop a furnace for processing solidification experiments in 0-g. Based upon market surveys, the company expects to market services and samples to academic and industrial researchers.

Predicated upon negotiations and proposal activities with various industries, other joint activities are anticipated shortly covering commercial interests in semiconductor crystal growth and glass like alloys.

Realization of the commercial potential of MPS is still many years away but the increasing industrial interest and the economic potential from improved terrestrial techniques, as well as some materials that might be uniquely produced in space, signal a technology ripe for exploration by the government and exploitation by the private sector. Toward these goals, a compfehensive NASA sponsored research program continues to evolve flight experiments for future Space Transportation System (STS) missions. Experiments of scientific and practical importance have been accomplished during the past year using various techniques and facilities to simulate the 0-g environment of space. Employing sounding rockets to carry experiments, investigators this year have achieved incontrovertible evidence of refined microstructure and uniquely high magnetic properties in composite crystals (manganese-bismuth) produced in 0-g; these results are sufficiently unique that existing theories relative to this type crystal growth must be

revised. Also, it has been conclusively demonstrated that highly uniform solid mixtures of dissimilar model metals (aluminum and indium) can be achieved in a gravity-free environment whereas such materials instantaneously segregate when solidified on Earth; thus, opening the technological potential for 0-g production of unique metallic materials. Other experimental results have confirmed the applicability of earlier data and resultant theories using simple model materials to the complex process of casting in more practical alloys, and have confirmed that the elimination of gravitational convection produces castings with a highly desirable large grain structure that, under the proper growing conditions, might approach single crystal structure. The culmination this year of several series of experiments combine to demonstrate the potential of producing unique glass materials through containerless processing in space; experiments have demonstrated that glass materials can be melted, controlled, and solidified while suspended by an acoustic field, and another experiment has demonstrated that glass materials can be purged of deleterious gas bubbles (process is called "fining") in 0-g by use of thermal gradients. Although the tenth in a series of sounding rocket payloads has been developed and integrated, the launch planned for the first quarter of this year has been cancelled due to budget reductions.

Two scientific experiments are included in the STS-3 manifest; one involves the determination of electrophoretic mobility of biological samples and the other is to study the chemical kinetics involved in the formation of very small, uniform size latex spheres. The biological separation experiment is a precursor for experiments employing continuous flow electrophoresis on STS-4 and subsequent missions; the latex chemistry experiment (Figure 2) is the first of a series (STS-3 through 6) to understand the reaction mechanics so that the size of particles may be increased above the current commercial limitations either by improving Earth-based techniques or by processing in space. Several experiments are to be accommodated on STS-7 when the first Materials Experiment Assembly (MEA-A), a self-contained payload package that contains, operates and services up to four experimental instruments, makes its initial flight (Figure 3). The experiments embrace the study of immiscible alloys, semiconductor detector crystals, and the formation of unique glasses. The MEA and its experiment devices are assembled and, over the next months, will be undergoing various tests in preparation for the mission. The MEA will be reflown repeatedly with various

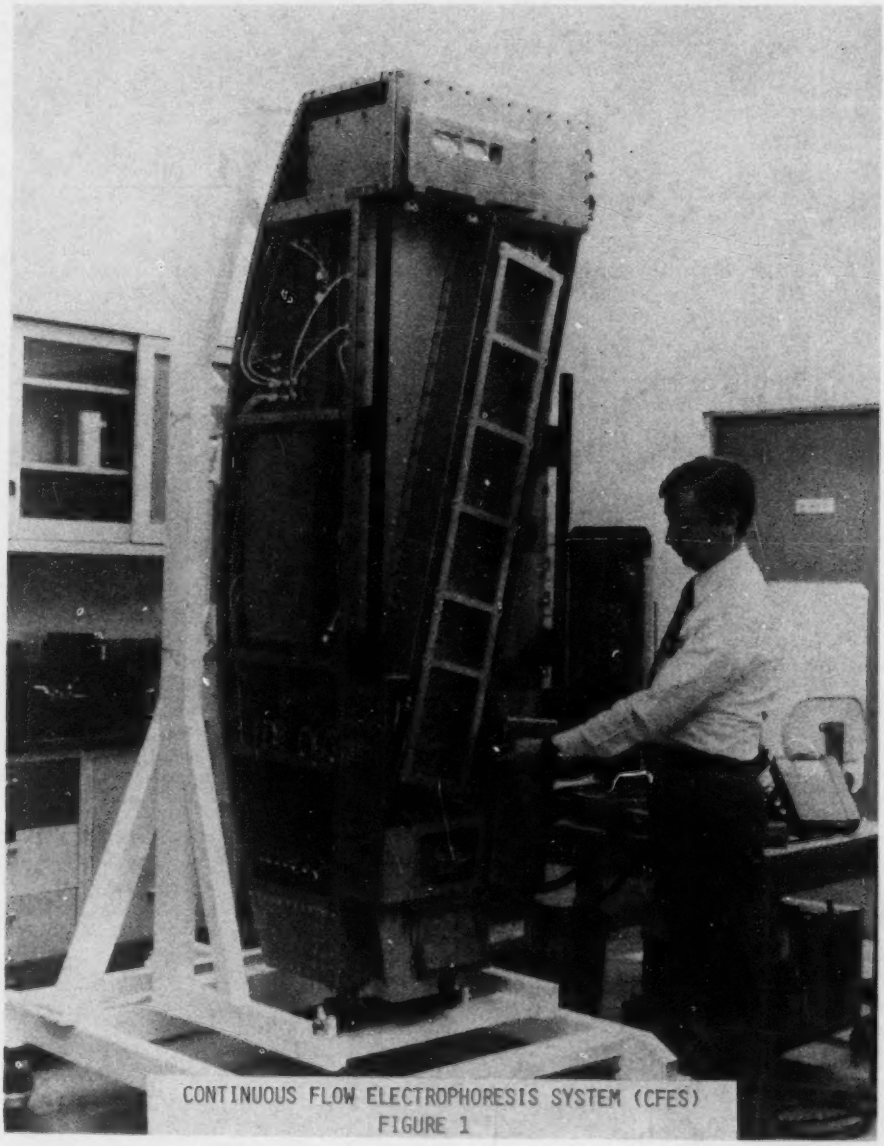
experiment complements. To accommodate the investigator requirements for flight ooportunities, a second flight unit (MEA-B) is expected to be upgraded from existing test hardware and will provide more power and cooling for the more demanding experiments. Subject to the availability of funding, various sounding rocket experiment devices are being modified for use in the STS and new experiments are being designed to meet investigator functional needs.

Development of flight hardware for the Spacelab 3 mission has matured significantly over the past year and hardware is now being integrated into Spacelab racks for functional testing (Figure 4). On the first of several planned missions, two detector crystal growth experiments are planned; one employing solution growth techniques for infrared detectors, and the other, vapor growth techniques for gamma ray detectors. Due to priority assignments and cost growth, development of a highly advanced furnace system for metallurgical and crystal growth experiments was terminated. That hardware which had been completed has been delivered to the government for potential future use and, to the extent feasible, investigators will be given access to other experimental devices to complete at least part of their experimental objectives.

In the coming year, the MPS program will have its first opportunities for flight experiments on the Space Shuttle. Although initial experiments are scientifically and commercially modest, the opportunity for experimentation onboard Shuttle constitutes a quantum increase in the experimental potentials since, to date, the program has been limited to less than 10 hours of 0-g time for all space flight and simulation experiments. The broad base of current scientific and commercial experimental requirements will necessitate a continuing series of flight experiments utilizing the Orbiter middeck facilities, the MEA, and the Spacelab.

Increasing recognition of the economic potential of the MPS technology is evidenced by the expanding role of the private sector in applied research studies and precommercialization flight experiments, as well as increased foreign commitments to MPS programs.

[Figures 1-4 of Mr. Zoller's prepared statement follow:]



CONTINUOUS FLOW ELECTROPHORESIS SYSTEM (CFES)
FIGURE 1

VAPOR CRYSTAL GROWTH SYSTEM (VCGS) IN SPACELAB RACK
FIGURE 4

February 12, 1982

STATEMENT

OF

MR. LUTHER E. POWELL
MANAGER, SPACE PLATFORM PROJECT OFFICE

PROGRAM DEVELOPMENT
MARSHALL SPACE FLIGHT CENTER

FOR THE

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee:

This statement provides a general overview of the Space Platform Project with emphasis on the progress that has been made during 1981.

The following information presents the status of current planning efforts and describes several possible uses and courses of action. However, please note that this program has not been approved for development. Further, the possible schedules and capabilities discussed reflect one set of a wide range of possible options being developed for future consideration and do not necessarily reflect the current views of either NASA or the Administration.

MSFC is considering to propose a Space Platform as a new start in FY 1984. Current program planning is based on the Phase C/D RFP release to the two Phase B contractors in early 1983 if this was approved as a new start in FY 1984. Under OMB Circular No A-109, the competition is limited to these two contractors. With authority to proceed in January 1984, the Space Platform could be launched as early as the summer of 1988.

The concept of an orbiting Power System was proposed to NASA Management by the Marshall Space Flight Center (MSFC) in the Spring of 1977. Subsequent concept definition resulted in the "25 kw Power System" which was assigned to MSFC for further study in February 1979. The name has since been changed to Power System Platform then to Space Platform.

The proposed Space Platform could be placed in low-earth orbit by the Space Shuttle to serve as an orbital platform providing various resources; i.e., electrical power, heat rejection, communications, and attitude stabilization for a variety

93-418 O—82——40

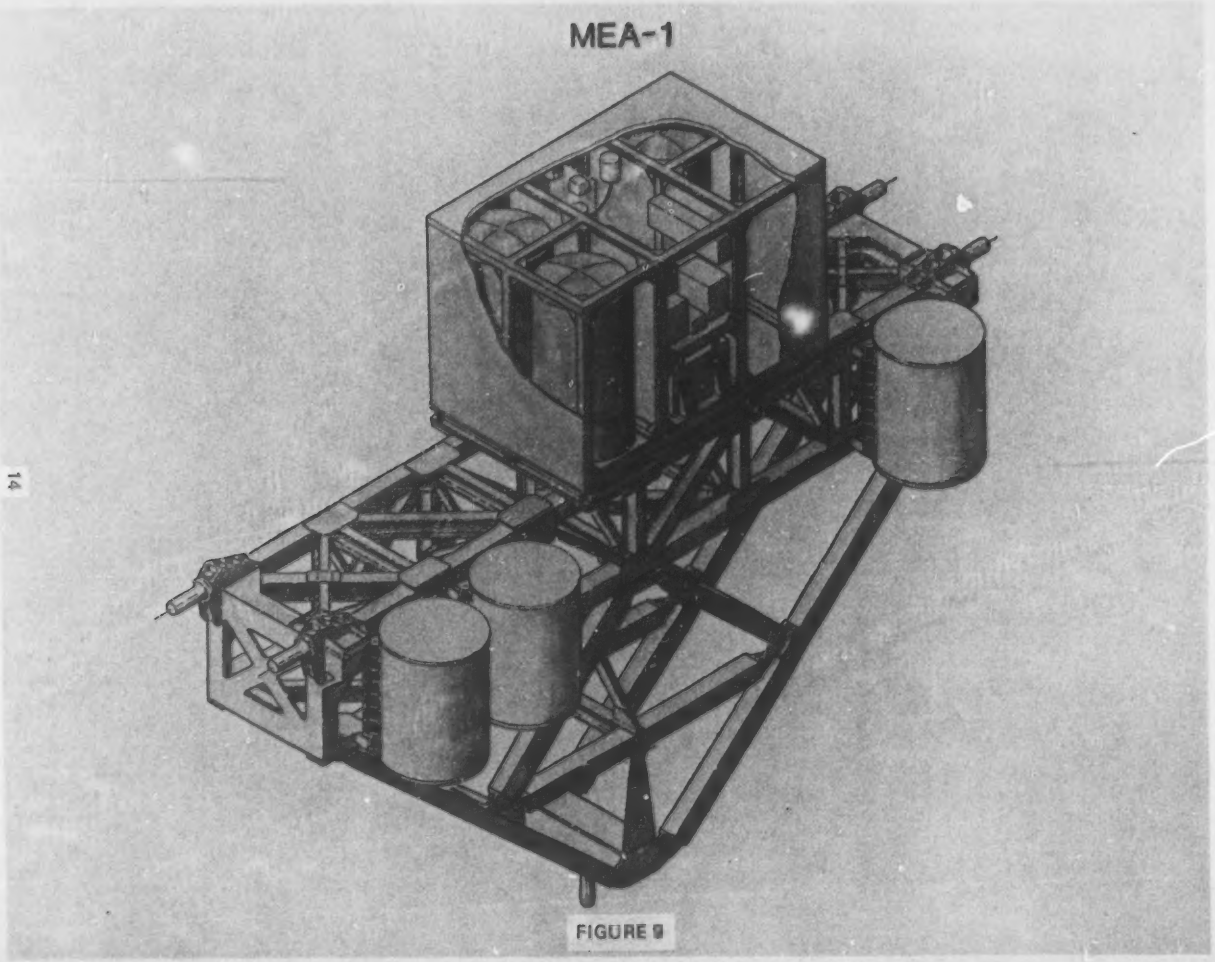
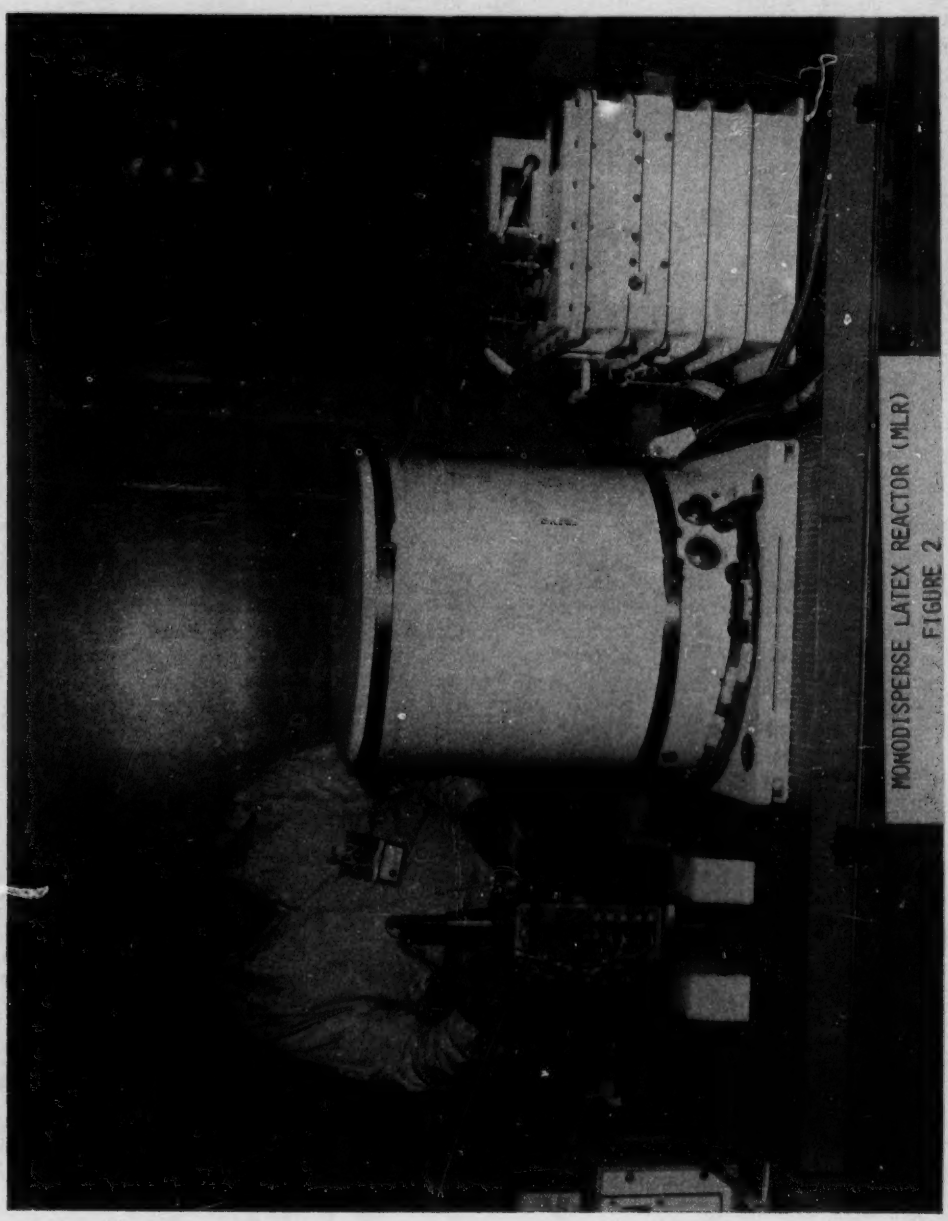
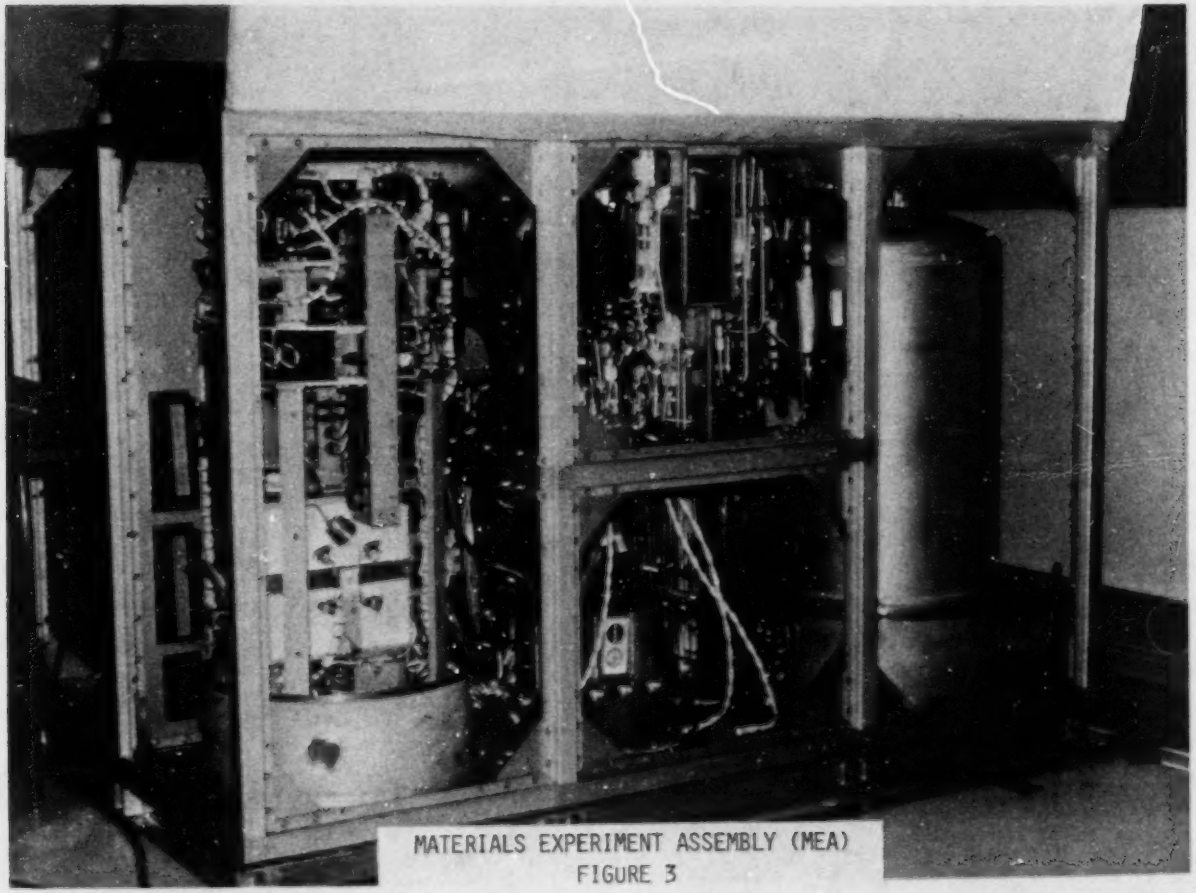


FIGURE 9



MONODISPERSE LATEX REACTOR (MLR)
FIGURE 2



MATERIALS EXPERIMENT ASSEMBLY (MEA)
FIGURE 3

of payloads. Figure 1 reflects the proposed configuration of the Space Platform which could provide simultaneous support for three different payloads with the ability to reorientate the individual payloads relative to the basic platform thus allowing a high degree of viewing autonomy and operational efficiency. These payloads could draw resources from the Space Platform and therefore stay on orbit greatly extended periods of time. Periodic revisits by the Space Shuttle could be used for payload changeout and updating as well as Space Platform maintenance.

Space Platform Phase B studies with McDonnell Douglas and TRW were started in June 1980 and completed in July 1981. These studies produced two mature preliminary designs of the Space Platform as well as the technical and programmatic documentation (specifications, interface documents, development plans schedules and costs) required to initiate full scale development. The contractors are currently funded to perform special emphasis and pre-development tasks as follow-on to the Phase B studies. These activities will continue through December 1982.

The Space Platform could be the cornerstone of a potential future policy for increased U.S. presence in space in that it could be configured to grow to higher resource levels to support any future evolving unmanned and manned space program. The Space Platform has been envisioned from the beginning as a minimum cost program which is in keeping with the current economic environment. This has led to maximum utilization of existing flight qualified hardware from current space programs such as the Shuttle, Spacelab, Landsat, etc., to minimize program cost and risk. Extensive risk and cost analyses have been conducted this year to surface any potential areas of significant program risk. The results indicate that the Space Platform is a low risk program with no new technology and a limited number of new hardware-/software designs required. To further minimize program risk, engineering models of new design elements such as solar arrays, radiators, cold plates, berthing mechanisms, etc., have been fabricated and tested by the Space Platform contractors. The contractors have also devoted significant effort this year to the analyses of effective and efficient methods for on-orbit and ground handling the large amounts of data expected to emanate from the Space Platform and its payloads.

During 1981 the Space Platform contractors continued to review the potential evolutionary manned and unmanned applications of the Space Platform and have reflected these long range possibilities into the Space Platform design to assure its growth compatibility. The Space Platform is being planned to meet the reliability and safety requirements of the Space Shuttle program and thus could be compatible with future manned space applications.

The scientific community has been heavily involved in the Space Platform from its inception. Early studies were conducted by scientists from many disciplines to determine future requirements and modes of operation. This early activity culminated in August 1979 in a science workshop specifically oriented toward an assessment of the applicability of the Space Platform concept. This workshop concluded that space platforms were a logical and desirable way of carrying out potential scientific goals in their disciplines. The overwhelming conclusion of the workshop participants was that the Space Platform concept should be pursued. During the Pre-Phase B definition phase for the Space Platform, a user review group consisting of representatives of the scientific disciplines has met periodically to review the design concepts and advise NASA on platform concepts, mission objectives, flight scenarios and scientific priorities. In addition to this, user review group periodic discussions have been held with various committees of the National Academy of Science. These interactions have generated considerable interest in the concept of a Space Platform as a cost-effective means of carrying out many science/applications programs. This interest is based on the flexibility to accommodate a variety of payloads; the possibilities for a number of relatively large payloads for simultaneous observations; the opportunities for servicing payloads through routine Shuttle visits; and the relatively quiescent environment as compared with the Shuttle. During 1980, studies of Science and Applications Space Platforms (SASP) and other studies by future potential Space Platform users developed potential requirements and design referene missions for such a possible future system.

In 1981, the scientific community has continued to be involved in the Space Platform studies. These studies have begun to address the accommodations of several science disciplines into a Space Platform mission and have addressed the desire of the science payload to maintain the degree of autonomy which allows for the independent

development of the science instruments and for unencumbered mission operations of a discipline payload. The Space Platform Program objectives has been responsive to the science community as reflected in the design of the flight systems and in the concept of the mission operations. The flight systems design reflects a standard payload interface which provides utility services to the payload with a minimum of integration activity. This is reflected in the design of the utility services of electrical power, thermal control, command and data management which provides the resources required while allowing the maximum autonomy to each payload port. The mission operation concept also reflects the payload autonomy through the separation of the control of Space Platform subsystems from the control of the payloads. The Space Platform studies of possible future science requirements have been greatly enhanced by the establishment of a technical exchange with all of the scientific disciplines. The disciplines have selected scientific investigations and instrument concepts which are representative for Space Platform missions. The exchange of data with these payload representatives will allow the implementation of the Space Platform design and the development of the mission operation to best meet the objectives of the science in the most effective way.

The Space Platform concept could meet the possible future need of science investigations over many years of operational life and is potentially a key system element of the evolution of an early manned platform. While long term requirements must be accommodated, the early use of the Space Platform must also be addressed. The scientific instruments that have been developed for the Shuttle/Spacelab missions are prime candidates for reflight with the Space Platform, and the scientific instruments currently under development as free-flyers with dedicated spacecraft are being addresssed as Space Platform payloads. These latter payloads are of interest since they represent possible near term uses of a low earth orbit mission Space Platform.

Some possible payloads which could be accommodated on an early Space Platform mission include the commercial joint endeavor Electrophoresis in Space (EOS), a U.S. and/or German Materials Processing in Space (MPS) payload and the Upper Atmospheric Research Satellite (UARS).

[Figures 1 of Mr. Powell's prepared statement follows:]

FIELD HEARINGS

SATURDAY, FEBRUARY 13, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Martin Marietta, Michoud Division, New Orleans, La.

Dr. SIEBEL. Mr. Chairman, Chairman Fuqua, we are delighted to have you here; and I would like to take this opporunity to introduce the NASA folk in the room.

We have John Hill, who is the ET resident manager; and, behind you we have my deputy, Mr. Williams; Mr. Lagarde, who is contracts and business management; and Mr. Demarest, who will be working with your Mr. Williams on facilities later today. He's in charge of facilities for me.

Mr. LINDSTROM. We also have Porter Bridwell over here.

Dr. SIEBEL. I'm sorry, I didn't introduce you.

Mr. LINDSTROM. And Jerry Smelser, who is here as head of production and management.

Dr. SIEBEL. Michoud, as you may recall, is one of three major NASA installations in this region (fig. 1); there is Michoud in New Orleans; and there is the Slidell Computer Complex in Slidell; and, of course, the other installation is in Mississippi. The Marshall Space Flight Center is responsible for these two and for certain activities at the National Space Technology Laboratories.

The Michoud facility (fig. 2) itself is quite large. It is roughly triangular in shape. It is bounded on two sides by water and on the third side by a major highway.

You can see that—and I won't go through this in detail—(fig. 3) we have very large buildings; and what makes Michoud so particularly appropriate for our space vehicle needs is that we have large manufacturing buildings suitable for building stages and at the present time Shuttle external tanks.

We have access to waterways, which allows us to transport our product to the Cape, to test sites, to the west coast ultimately; and, last, but not least, we have an industrial infrastructure here in the sense that we have roads, we have drained ground, we have utilities, a guard force. We have all the industrial infrastructure needed for an activity of this type.

MAF is a fairly old plant. The bulk of the plant was built in World War II initially to build Liberty Ships and later to build aircraft (fig. 4).

During the Korean conflict the plant was taken over by the Army for tank engine production. Of course, they added some buildings, and in 1961—we had our 20th anniversary about 6

months ago—NASA came here for the assembly of major launch vehicles; today we are building here the external tank.

Each of these activities that I mentioned added buildings and facilities to the total, but the core of the plant, as I said, is quite old.

The objectives of our organization (fig. 5) here are primarily and first and foremost to support the external tank by having a reliable, consistent industrial base.

This includes roads, utilities, a guard force, cafeterias. You name it, we've got it: a boiler house, a port. All these things we take care of in terms of facilities support services and whatever management systems are needed.

Additionally, we have fewer people here today than we did when we had both Chrysler and Boeing here building stages concurrently for the Saturn program; and at the end of the Saturn program we made a decision to make available to certain other Government agencies a part of the plant, mainly office space, and this on a cost-sharing basis; it is more economical for us not to have empty space.

We also provide locally a public relations capability, and we work quite closely with various local government bodies so as to enhance, and to help them enhance the industrial capability, particularly of east New Orleans.

The space-related activities at Michoud (fig. 6)—and we only have about 30 NASA folk here—are primarily carried on, of course, by the Martin Marietta Co. on the external tank project. We delegate certain responsibilities to the Defense Department in the form of Defense Contract Administration Services and Defense Contract Audit Agency, who do our quality and reliability and audit functions and Government property management and that kind of function.

We operate the industrial infrastructure that I mentioned earlier through the use of facility operating contractors. We have one principal contractor who performs these functions, plant engineering and so forth; and then we have three 8(a) set-aside contractors who take care of security, reproduction, and custodial services.

Additionally, we have a constant stream of contractors, many of whom are also small business, to do the rehabilitation work.

These are typical projects. Some are quite large; some are quite small. We have to improve the drainage; we have to improve the roads, sewer lines, and so forth. I'll come back to these construction projects; but just for completeness in what is related to in the space project activities here, these are the kinds of things.

The total employment (fig. 7), if you were to draw a line here, this would be space related and here we have Martin and some subcontracts, NASA, DCAS, DCAA, our facility operating contractors, and all that adds up to about three-quarters of the 5,600 or thereabouts. It's about 4,200 to here and 5,600 to here. Our principal tenant is the Department of Agriculture.

When you were last here, Mr. Chairman, we had a large contingent of Census, but they're practically gone, their project being over.

I would go over very rapidly on this. If there were questions, of course——

The C of F projects which related to the industrial base. I will not touch upon those which have to do with specifically and uniquely the production of the tank, but every time you build a facility for the tank, of course, it has to have its industrial base support in terms of heating, janitorial service, and whatever; but these are, as I said, the 1980 projects (fig. 8) which are essentially complete.

Then we have the 1981 projects (fig. 9) which are getting toward completion, and the previous one is about $8 million, and this is about $7 million. These (fig. 10) are the current year projects which are in process, and we have much less. The prior projects were driven to an extent by the rehabilitation of our boiler plant and such, the boiler plant being where we get our environment for the manufacturing activities. We need a dry and controlled temperature environmental for the tank production, so the boiler plant is essential to production.

These are the projects submitted to the Congress at present for fiscal year 1983 (fig. 11).

And finally on the next slide (fig. 12) are the projects we deem necessary for fiscal year 1984, but they haven't, of course, come to you in any way yet.

Congressman FUQUA. The building is getting old. You can see that.

Dr. SIEBEL. Yes; this is an office building rehab, and, Mr. Chairman, you mentioned that you were here before and you were in a different building; and that was the different building you were in; and they're getting old; they're contemporaneous with the World War II construction, and that's what drives that figure up largely; and, of course, storm drainage is an important consideration around here.

In summary (fig. 13), we are quite proud of our plant. It is strategically located. We have managed it quite successfully, and it is recognized locally that we have quite an economic impact, in fact, we are the largest industrial complex in Orleans Parish; and we hope, of course, with all this nice space we have, to be assigned other projects in due course.

Congressman FUQUA. You have other Government tenants?

Dr. SIEBEL. Yes, sir.

Congressman FUQUA. Do they contribute any to the overall maintenance? I know you're the landlord but——

Dr. SIEBEL. We levy on them charges that are proportional to the services that they use.

Congressman FUQUA. For modifications?

Dr. SIEBEL. No, not for facilities projects. In some instances, for example, Census did some modifications to the building, but they did it.

Congressman FUQUA. I'm talking about if you were talking about redoing something with the air-conditioning or the feeder lines for the electrical power. I assume they benefit by that, also.

Dr. SIEBEL. They do, sir.

Congressman FUQUA. But they make no contributions toward this facility improvement?

Dr. SIEBEL. No; they don't, sir.

Are there any other questions?

Well, thank you very much.

[Figs. 1 to 13 of Dr. Siebel's oral presentation follow:]

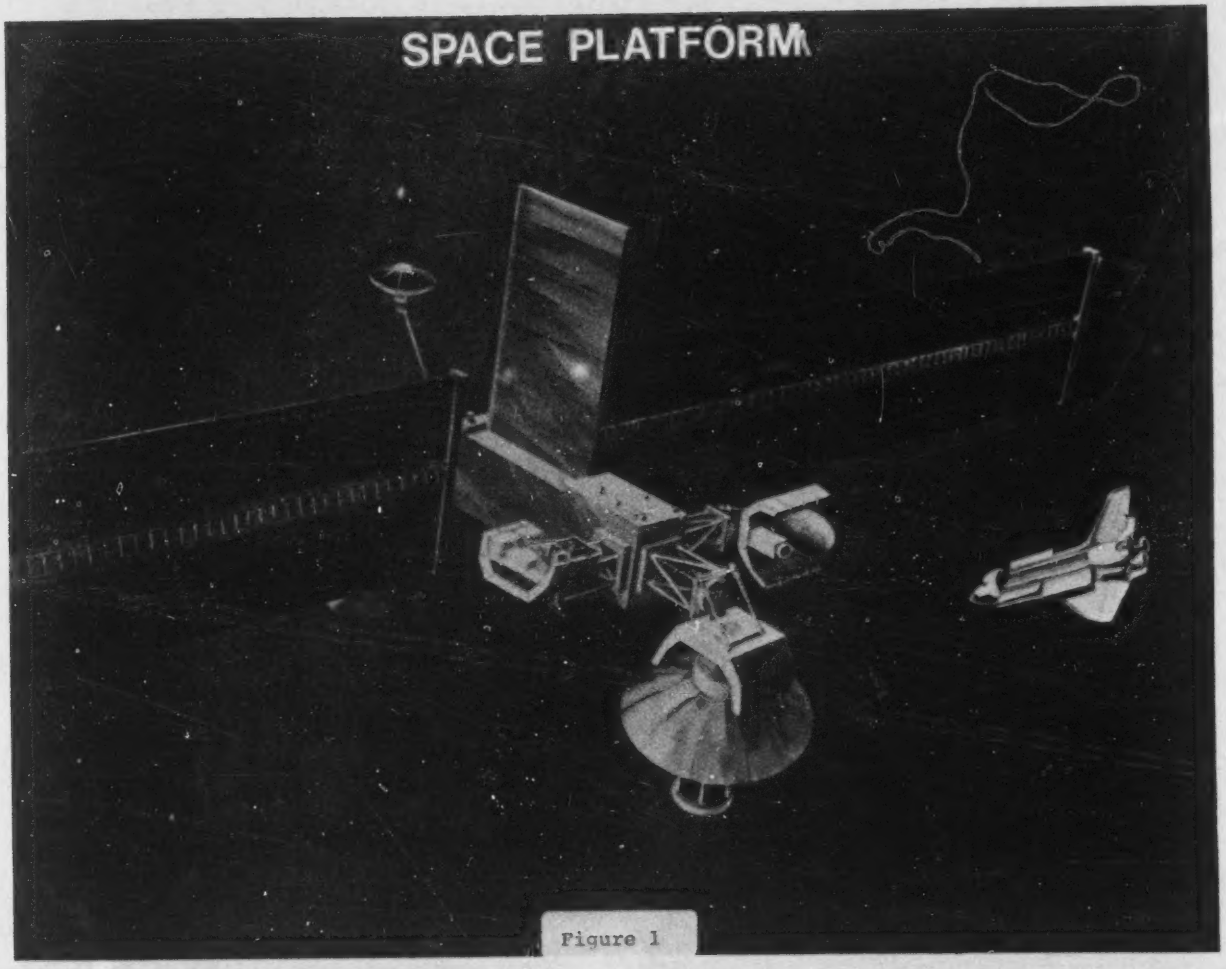
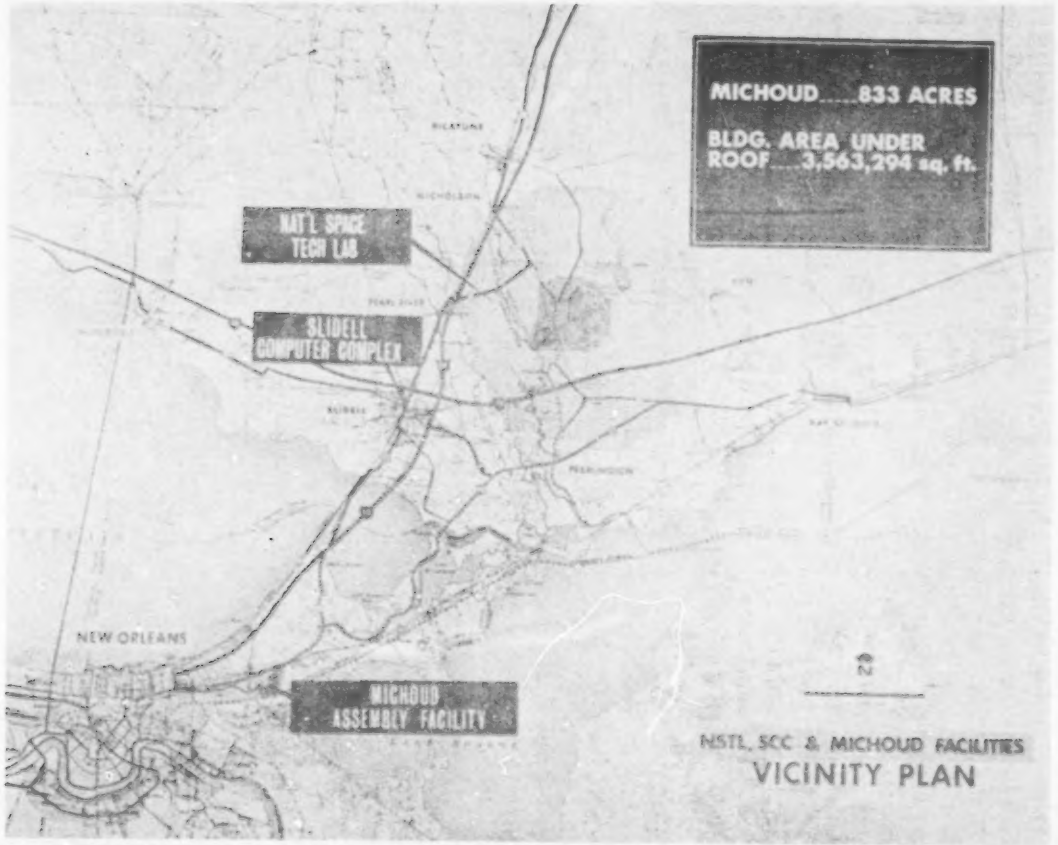
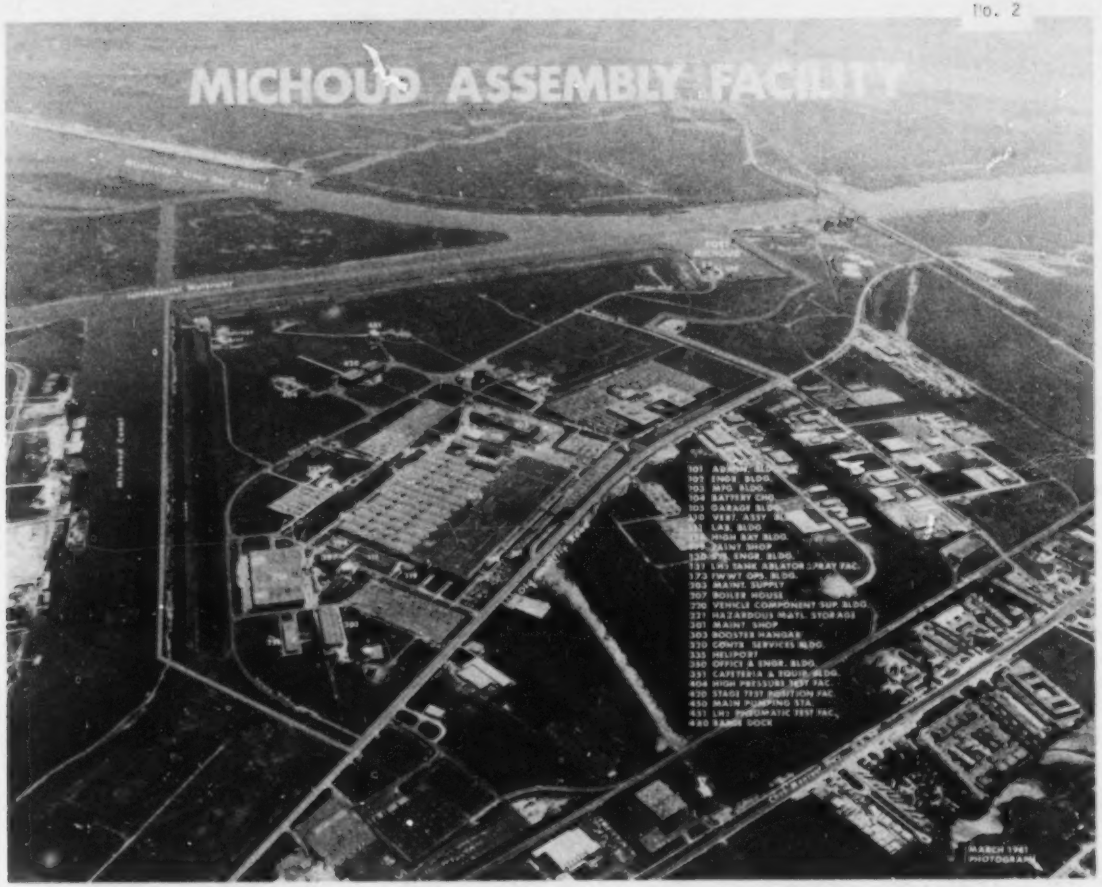


Figure 1


MICHOUD.....833 ACRES
BLDG. AREA UNDER ROOF....3,563,294 sq. ft.
NAT'L SPACE TECH LAB
SLIDELL COMPUTER COMPLEX
NEW ORLEANS
MICHOUD ASSEMBLY FACILITY
20
NSTL, SCC & MICHOUD FACILITIES
VICINITY PLAN


MICHOUD ASSEMBLY FACILITY
MARCH 1981
PHOTOGRAPH

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS SM01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 3 DATE Feb. 13, 1982 SPEAKER Mathias P. Siebel

FACILITIES

Largest and Most Diversified Development and Production Facility in the NASA Inventory

- Land: 833 Acres
- Total Buildings Area: 34 Buildings — 3,768,000 sq.ft.(86.5 acres)
  - A. Office Area: — 902,434 sq.ft.(20.7 acres)
    Includes Administration, Engineering, Design, Planning, Test Support, etc.
  - B. Manufacturing & Special Tests Area: — 2,467,980 sq.ft.(56.7 acres)
    Includes Laboratories, Development & Production Areas Suitable for Research & Development, Fabrication, Sub-assembly, Final Assembly, Processing, Testing & Checkout Space Launch Vehicles & Payloads
  - C. Institutional Support Area: — 397,598 sq.ft.(9.1 acres)
    Includes Plant Engineering, Maintenance & Operations, Central Boiler Plant, Utilities Distribution Systems, & Trade Ships; Roads & Grounds; Security, Fire & Medical Depts.; Photo., Repro. & Printing; Warehousing & Storage Areas
- Computer Support - Remote Terminals from NASA-Slidell Computer Complex
- Waterway Access: Port Michoud, Home Port for "NASA Navy", provides Ready Access by Water to MSFC, KSC, NSTL, JSC & VAFB

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS SM01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 4 DATE Feb. 13, 1982 SPEAKER Mathias P. Siebel

HISTORY OF UTILIZATION

1942 - 1945	Acquired by U. S. Government for Ship and later for Aircraft Production
1951 - 1953	Army Tank Engine Production
1961 - Present	NASA Launch Vehicle Production for Apollo, Skylab, Apollo/Soyuz & Space Shuttle

Program	Prime Contractor
S-I	Chrysler
S-IB	Chrysler
S-IC	Boeing
Shuttle External Tank	Martin Marietta

NASA-MSFC-MAF SF-PC-003 (OT) (OCT 77)

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS SM01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 5 DATE Feb. 13, 1982 SPEAKER Mathias P. Siebel

OBJECTIVES

0 To prepare the MAF industrial base to support External Tank production, including

- Facilities
- Support Services
- Administrative & Technical Management Systems

0 To improve economy in government operations by sharing the MAF industrial base with other agencies

- On a non-interference base
- With equitable cost reimbursement

0 Provide a public relations capability to represent NASA/MSFC in Louisiana and to assess the impact of MAF programs, objectives, and policies on the economic, social, and governmental relationships of the surrounding communities; provide for dissemination of public information.

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS 5M01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 6 DATE Feb. 13, 1982 SPEAKER Mathias P. Siebel

ACTIVITIES

Space Flight Project

0 Space Shuttle External Tank Project	Martin Marietta Corporation
0 Quality & Reliability Assurance	Defense Contracts Administration Services
0 Contracts Audit	Defense Contracts Audit Agency

Facility Operating Contractors

0 General Facility Operation & Services Including Plant Engineering, Maintenance & Operations; Transportation; Food, Medical & Other Technical Services.	Global Associates, Int'l. (Hollins & Hollins, Inc.) (Morrison's)
0 Security, Fire Protection & Visitor Control	REguard Security Svcs., Inc.
0 Photographic & Printing Services	Robinson Printing Co., Inc.
0 Custodial Services	Red Services Co.

Construction Contractors (Typical)

0 D&O Contractors	Rehab Asphalt Roadways
0 Brothers Construction	Repair Drainage Canal
0 BRS	Painting Bldg. 103
0 Gallo Mechanical	Replacement of Natural Gas Line
0 Guaranty Industrial Cont.	Replace Refrigeration Machine B.207
0 Gaffney, Inc.	Replace Sewer Lines
0 Gallo Mechanical	Condensate Lines Repair

GEORGE C. MARSHALL SPACE FLIGHT CENTER
MICHOUD ASSEMBLY FACILITY
PERSONNEL STRENGTH
AS OF 2/1/82

ET PROGRAM				
MARTIN MARIETTA AEROSPACE	(ET PROGRAM)	3,311		
MARTIN MARIETTA AEROSPACE	(OTHER)	137		
Subcontractors		285	Subtotal	3,733
Boeing	103			
Prod. Engr.	58			
Red Custodial	43			
Landis Const.	4			
Goodwin & Co.	28			
I. Alper Co.	8			
Leonard B. Hebert	33			
Facility Manpower Support	1			
Product Eng. Manpower	4			
Veteran Elect.	3			
NASA		32		
DCASMA NEW ORLEANS		77		
DCAA		12	Subtotal	121
FACILITY SUPPORT CONTRACTORS				
GLOBAL ASSOCIATES		205		
SUBCONTRACTOR		43		
REGUARD SECURITY SERVICES		74		
RED SERVICE CO., INC.		54		
ROBINSON PRINTING CO., INC.		41	Subtotal	417
TENANT AGENCIES				
BUREAU OF THE CENSUS		49		
U. S. DEPARTMENT OF AGRICULTURE		1,149		
NAVAL BIODYNAMICS LABORATORY		97		
DCASMA NEW ORLEANS		52		
DCAA		27		
CHRYSLER CORP., DATAMAN		15		
CITY OF NEW ORLEANS/AMID		1		
DEPT. OF COMMERCE/NAT'L MARINE FISHERIES SERVICE		3		
AIR FORCE/MMA/MX PROGRAM		4	Subtotal	1,397
			Total	5,668

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS MICHOUD ASSEMBLY FACILITY SMOT	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 8 DATE FEBRUARY 13, 1982 SPEAKER MATHIAS P. SIEBEL

INSTITUTIONAL CONSTRUCTION OF FACILITIES PROJECTS - FY 1980

	PROGRAM PLAN	CCE	STATUS
o ELECTRICAL FEEDERS 10/35	160,000	93,000	CONTRACT AWARD 2/82, EST. COMP 6/82
o REPLACE ROOF 103	3,100,000	3,100,100	73% C. COMP. EST. COMP. 3/82
o REPAIR OF VARIOUS BLDGS.	420,000	185,000	PH. I COMP., PH II CONSTRUCTION START 2/82, EST.COMP. 5/82
o REHAB STEAM COND. SYSTEMS (103)	275,000	81,000	COMPLETE 10/81
o REHAB & MOD HVAC (FANHOUSES)	300,000	340,000	COMPLETE 8/81
o REHAB MOTOR CONTROL CENTER	120,000	50,000	COMPLETE 6/81
o MOD BOILER PLANT/#5 & #6 OIL	400,000	525,000	COMPLETE 8/81
o CONST. 500,000 GAL. TANK	850,000	510,000	COMPLETE 7/81
o MOD PLATFORM & SAFETY MODS	110,000	64,000	COMPLETE 5/81
o REHAB STRUCTURES AND ROOF (207)	285,000	240,000	COMPLETE 10/81
o INSTALL. of 10" STEAM & COND.LINE	375,000	420,000	COMPLETE 10/81
o REHAB EXT. GAS MAIN LINE	480,000	420,000	COMPLETE 9/81
o MOD TO LIGHTING, B. 350	230,000	200,000	COMPLETE 1/81
o REHAB CAFETERIA 102/103	150,000	148,000	COMPLETE 8/80
o BOILER CONTROLS	405,000	465,000	COMPLETE 12/81
o REPAIR COOLING TOWERS	360,000	360,000	COMPLETE 5/81
o REPAIR OF ASPHALT ROADS	210,000	210,000	COMPLETE 8/80
o REPAIR OF CHILLERS, B. 351	115,000	339,000	COMPLETE 3/81
o REPAIR 220 ROOF	480,000	491,000	COMPLETE 9/80
TOTAL INSTITUTIONAL	8,825,000	8,241,000	

NASA-MSFC-MAF 9F-PC-003 (OT) (OCT 77)

93-418 O—82——41

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS MICHOUD ASSEMBLY FACILITY SMOT	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 9 DATE FEBRUARY 13, 1982 SPEAKER MATHIAS P. SIEBEL

INSTITUTIONAL CONSTRUCTION OF FACILITIES PROJECTS - FY 1981

	PROGRAM PLAN	CCE	STATUS
o REHAB CHILLED WATER SYSTEM	782,000	770,000	PH.I 30% C. COMP., PH II - 60% D. COMP.PH III-90% D. COMP.& 35 C.C.
o REHAB STEAM BOILER NO. 2 (B. 207)	335,000	480,000	30% C. COMP.,EST. COMP. 4/82
o MOD FOR AUTOMATION OF BLDG. SYST.MGMT.	205,000	205,000	5% D. COMP - HEADQUARTERS HOLD
o REPAIR ELECTRICAL FEEDERS 14/15	200,000	200,000	CONT. AWARD 2/82, EST.COMP.6/82
o REPAIR EAST MASTER SUBSTATION	430,000	410,000	DESIGN 1/82 - 4/82
o REPAIRS TO DRAINAGE CANALS	180,000	180,000	95% C. COMP., EST. COMP. 3/82
o REHAB ROOF PH II BLDG. 103	3,800,000	3,800,000	8% C. COMP., EST. COMP. 9/83
o MOD SUBSTATION 20 & 44, B. 110	140,000	145,000	98% C. COMP., EST. COMP. 3/82
o REPAIR ROADS AND PARKING LOTS	240,000	240,000	COMPLETE 10/81
o REPAIR SEWERLINE IN ROOF (B.103)	440,000	400,000	COMPLETE 10/81
TOTAL INSTITUTIONAL	6,752,000	6,830,000	

STATEMENT OF KENNETH P. TIMMONS, VICE PRESIDENT AND GENERAL MANAGER

Mr. TIMMONS. Mr. Chairman, Chairman Fuqua, staff members, program associates, I am Kenneth Timmons, vice president and general manager, Michoud Division, Martin Marietta, Denver Aerospace.

My associates with me today, begining on your left, Tom Wirth, external tank director, Kennedy Space Center, operating under a separate contract we have here with the Marshall Space Flight Center.

Down the line is Dick Foll, our director of engineering; Clive Beasley, director of planning; and for the facilities and plant services, Randy Tassin.

On your right, Ric Davis, vice president, my deputy, and he runs the external tank program.

Next down the line, Al Norton, our vice president for development, our No. 1 technical man here.

Then at the end of the table, Bob Lopez, who is finance and estimating for the external tank.

Down the middle, Dick Masi, who is director of business operations.

In front of him, Joe Spencer, director of program development; and you met our gentleman from headquarters.

The agenda showed that we would have a brief presentation. There will be about a 14-minute tape I would like to show. Then we'll be on a tour of the facility and the tour can be abbreviated or lengthened at your discretion.

Our plan, however, was to take you to the area of final assembly where two tanks are in final position and show you some additional development work that we're doing up to and through the new cells and the old cells, then out to the pressure test facility where we have automated the pressure test sequence for the hydrogen tank. A refresher for those of you who aren't too familiar with the external tank; and I would assume that to be largely, Mr. Irons. Most of the people here know it, I believe.

Just in summary, it has about six times as much oxygen as hydrogen by weight, about three times as much hydrogen as oxygen by volume. It delivers a 6-to-1 mixture ratio to the space shuttle main engines; and, as you can tell from the 6-to-1 versus the 8-to-1 stoichiometric for water that delivers to the atmosphere water and free hydrogen as a function of the burning in the Space Shuttle main engines.

The tank is 28 feet in diameter, 155 feet long, approximately 100-foot-long hydrogen tank, 50-foot-long liquid oxygen tank on the front, joined by the intertank and with the crossbeam in the intertank, the forward dome of the hydrogen tank, the aft dome of the LOX tank come within about 5 inches of the beam, so it's a full structure for its entire 155 feet of length.

Status of the production; we have two tanks at the bottom of the Indian Ocean after a very successful flight performance.

There will be a rollout at the Kennedy Space Center, I believe, now on Tuesday where ET-3 has been mated and will roll out to the pad.

External tank 4, as you can see, is also at the Kennedy Space Center being checked out by Tom Wirth and his people.

You will see in final assembly, external tanks 5 and 6 lined up side by side, these are the last of the heavyweights, the last of what we consider the D.D.T. & E. articles, or development articles. There are some differences in whether there are four development articles by some parts of the agency. We refer to the first six as development articles, D.D.T. & E. and the articles followed by the lightweight tanks. Lightweight tank 1 is the first of what we consider the production run, and that's 6,000 pounds lighter than the first six.

Transfer ratio of tank to payload is about 95 percent. We will have more than 6,000 pounds of savings; therefore, we will offer 6,000 pounds additional payload capability to the orbiter.

Reporting again on an item we have reported to you, Mr. Chairman, in the past, the small disadvantaged. We're caught up in terminology from a prior contract of also minority businesses, so I have covered them both here.

Public Law 95-507 introduced the new category of small disadvantaged, and that's one we have invoked on our supply contract. We still carry the minority figures. The results, I think, here have been excellent. You can see that out of the total value of the procurements that we have available, almost half of them went to small business. In the minority businesses, there were opportunities to bid representing over $15 million. The opportunities to bid reflect those areas that we can identify for which there would be qualified small disadvantaged or minority firms available. We work with those small firms to enable them to bid, to help them to get ready to bid. Of course, once the bid is in, no more preference will be given to the small disadvantaged. Therefore, they compete with the submittal of the bid. We have been successful in awarding over $6 million to the small disadvantaged businesses. We have been rated by the Small Business Administration and DCAS as excellent on all of our reviews. We have been nominated by the Defense Logistics Agency for a national award after winning the regional award in the small disadvantaged business area and we had a significant takeup of fee and an award for the work done in 1981 on the small disadvantaged business work.

Reviewing back over cost per flight history, also previously submitted in prior hearings, the cost per flight expressed in 1975 dollars in the upper left-hand part of the chart, you can see that the external tank and the MMC figures beside it indicate that, that is the cost that we track here for Martin Marietta Corp. and does not include additional program impacts that Jim Odom, the program officer, passes on in his figures to headquarters. You can see we have gone past our cost per flight dollars, 1975 dollars, to about 2½ million to a little over 4 million. The line below that is adjusted to 1981 dollars. So, taking off from those 1981 dollars, the pie chart shows at the top the negotiated baseline. The baseline as it was negotiated in 1981 dollars, 32 percent of the total cost represents the reflection of the total negotiated baseline. The mission model, and changes in stretchout of its shift in the midpoint, account for about 6 percent of the cost increase in the model. Inflation, and that's actual, that inflation actually experienced versus the 5-percent flat

rate negotiated at the outset accounts for about 32 percent additional increase in the cost per flight model. The 4 percent labeled experience is the area in which we were unable properly to predict the actual cost in the future. It is that that we learned on the development program and, in particular, in the thermal protection system area where we, and I think the industry in general, had not fully mastered the application of thermal protection systems, represented growth during the development program, and that growth in cost is reflected on in the production program.

Congressman FUQUA. Ken, I know you have no control over inflation, but the added scope that's on there, do you anticipate there will be any more of those once you start with the new lightweight tank?

Mr. TIMMONS. I would like to say no, I certainly do anticipate there would be more. Mr. Odom, do you agree with me that there will be more?

Mr. ODOM. I think there certainly will continue to be some. There are a lot of them that are beginning to trade off. We're now learning enough about the vehicle, the performance of it, that we can insititute both operational and cost reductions. There will be some mission peculiar improvements that will help the operation of the vehicle that may come into the tank and show an increase in the tank cost, but may end up lowering the total operational cost; so those are the two families that we're working very hard on now, to look at the things we can do to the tank and to make it easier to operate at the launch site. I think the big mission changes are over other than those that they're making in the two categories I just mentioned. We don't see any real big swings coming that should affect the configuration.

Mr. LINDSTROM. Mr. Chairman, there may be one issue, the question of ice protection at Vandenberg is not totally resolved since we have different atmospheric conditions at Vandenberg, therefore, that is still an open issue.

Congressman FUQUA. Will that be worse because it's a more drier climate there, is it not?

Mr. ODOM. It's a lower average temperature, you have a lot of fog conditions. The humidity right off the coast line is higher.

Mr. LINDSTROM. That's being very actively worked. In fact, we had a discussion on that with General Abrahamson and I yesterday.

Congressman FLIPPO. Ken, your cost per flight is different from any figures we've seen. What is the flight rate of the total number of flights assumed for that cost?

Mr. TIMMONS. MR. LOPEZ?

Mr. LOPEZ. Mission Model 444 flights at a production rate of 55 a year.

Congressman FLIPPO. Five a year?

Mr. LOPEZ. Fifty-five.

Mr. TIMMONS. Maximum production rate for full 55 per year.

Mr. ODOM. That was the original model they were pricing.

Mr. TIMMONS. In the other scope category you're asking about, those are additional requirements; and the figure, I think, of merit on that is that in addition to absorbing those requirements which increase the cost of the tank and, in some cases, reduce the cost of

some of the other major elements of the tank. Our percentage of the total program costs has stayed essentially constant and indeed has reduced very slightly, in spite of taking on those things like the ice and debris requirements, ice on the protuberances, the lightweight tank and its significant cost of development, and the recurring costs following a lightweight tank. Our other requirements, like the intertank material substitution, all of those have increased the cost. The ECO sensors [the engine cut-off sensors] increased cost as they came across the interface on to our side from the orbiter, but in spite of all those changes and those changes benefiting the overall program, the percentages of the total program which the external tank represents has held constant and slightly decreased over these years. I had said earlier, these are Martin Marietta program costs on our cost per flight model, and I suspect that what you see from headquarters will reflect additional element costs that Mr. Odom passes on to you.

I wanted to emphasize from this chart that when we took over this facility in approximately 1974, end of 1973, Boeing and Chrysler were the two businesses operating in the facility. We largely got the Boeing area. The Boeing area was utilized in the initial layout of the tooling and the major structural weld fixtures, and in 1981, we achieved full occupancy of the building. Chrysler was gone. Some of the warehousing had been cleared out, and building 103 is now totally and external tank building used by Martin Marietta. The thru-aisle is depicted on the right-hand chart. The thru-aisle is the key to cleaning the flow so that there are few back flows, fewer dolly moves, more crane handling to avoid the dolly moves, and it maximizes the process, staging, nearby storage of parts flowing to the line and shows on the chart that the LOX tank is largely processed on one side of the thru-aisle, the hydrogen tank on the other side of the thru-aisle. Then they meet at the major weld fixtures where the barrel sections and the domes become a tank.

Congressman FUQUA. Has that been changed now since you have the full use of the building?

Mr. TIMMONS. It is being changed now that we have full use of the building.

Congressman FUQUA. Do you have that chart?

Mr. TIMMONS. No; I do not have a more detailed chart, but the thru-aisle is totally new, is not yet in use, it is not yet laid out. From the start, we have positioned the tools so it would accommodate a thru-aisle; and when we got the full use of the building, we could relocate things, a few items have to be moved, in the way of the thru-aisle, such as the X-ray fixture and the X-ray room. We do not have to move major massive tooling. We did position the tooling on the hard points where it would accommodate a thru-aisle

The thru-aisle is the key to the orderly flow, and the higher production rates. This is just background here for the construction of the facility chart that I'll be showing and the production capacity chart.

In C of F, a good deal of discussion has gone on in this, and I'll be very brief with it. On the left, the fiscal year 1982, the first two major items are in under building 420, which is where we do the final checkout of the tanks prior to shipment, and the first one is

to beef up the floor and rehabilitate that building and that first cell so that we can use it in parallel with the second cell for the final checkouts of the tanks before they're delivered to the dock. The second item is to improve the environmental control of both cells so we can do the near room temperature application of BX250 type of thermal protection system and maintain the humidities and temperatures required for that work, which is the closeout of the thermal protection system items in the 420 building. You have seen the 1983 submittal that was given to you in some detail. The only items on there I wanted to emphasize of interest is that items 2 and 7 very likely will be out of the submittal from NASA pending the final agreement with NASA of Martin Marietta investing that money which puts the facility across the road here or nearby. The Martin Marietta building then would be used for the SLA components type of work. That would reduce items 2 and 7 and would allow us to put item 3 into fiscal year 1984 and reduce the expenditure for it.

Congressman FLIPPO. Ken, I'm sorry. Would you elaborate on why that's needed. Would that give you more space in your facility?

Mr. TIMMONS. It certainly will give us more space in the main building 103, but the primary reason, I think, the real driver in addition to coming up with new tooling for higher productivity, we would like to get the silicones out of building 103. If they stay there, we'll have to entrap the atmosphere from the super light ablator because it does have silicones, and that's a serious detriment to proper cleaning and bonding of the tanks. The silicone atmosphere can permeate the entire building 103. We want to isolate it, and we want to increase the tooling and the productivity of the components and that is presently a high labor intensive area. We'll show you some of that work which would be relocated to that facility when we and Marshall agree on building and constructing it as a Martin Marietta investment. Dr. Siebel showed you the building 102 being in fiscal year 1984. The building 102 rehabilitation has been in the plans for some time. My encouragement is to accelerate the rehab of building 102 and indeed to try to get in each year some amount of the construction of facilities money for the amenities, for the better quarters, better working conditions for our people as a part of the quality of worklife and part of the overall productivity effort to have better functioning employees.

Production capacity—the curved, the dashed line shows the present planned rate of 24 per year, and flattening out at 24 per year. In addition to that, we have the curve, which is what we ordinarily call the 60 minus 36 plan, with the 24 base rate and the capability ultimately to go to near 60 a year. On the earlier mission models, we have kept track of layout on the floor always to accommodate the ultimate growth up to near a 60-per-year rate. So it's a 60 minus 36 plan accommodating that ultimate maximum rate. You will see the steps in there which bring the cells on line which are previously approved in the C of F funding. In the future, the large triangle in the upper right, there would be additional C of F funding and tooling money required to make that step up from 24 or 27 or where the rate settles down after we get our tooling in and our learning curve time, then rate would be above 24 per year for some

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS MICHOUD ASSEMBLY FACILITY SA01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 10 DATE FEBRUARY 13, 1982 SPEAKER MATHIAS P. SIEBEL

INSTITUTIONAL CONSTRUCTION OF FACILITIES PROJECTS - FY 1982

	PROGRAM PLAN	CCE	STATUS
o REHAB ELECT. FEEDERS 12, 13, 17, 31	235,000	235,000	DESIGN COMPLETE
o REHAB STORM DRAINAGE PUMPS & CONT.	230,000	230,000	45% D. COMP., EST. D. COMP. 2/82
o MOD TO COND. RECOVERY (110, 103)	150,000	150,000	45% D. COMP. CONST. 6/82 - 2/83
o INSTALL. AIR DIST. SYSTEM (110)	365,000	365,000	DESIGN 1/82 - 4/82
o REHAB PILE CLUSTERS AND ANCHORS	120,000	120,000	100% D. COMP., CONST. 3/82 - 6/82
o REPAIR 625 TON CHILLER (350)	200,000	200,000	.75% D. COMP., EST. D. COMP.. 2/82
o REPAIR STEAM SUPPLY (110)	250,000	250,000	40% D. COMP., EST. D. COMP. 5/82
o REPAIR ROOF (420)	450,000	450,000	90% D. COMP.
o REPAIR SEWER LIFT STATIONS	190,000	190,000	80% D. COMP., CONST. 4/82 - 8/82
TOTAL INSTITUTIONAL	2,190,000	2,190,000	

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MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS MICHOUD ASSEMBLY FACILITY SM01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 11 DATE FEBRUARY 13, 1982 SPEAKER MATHIAS P. SIEBEL

INSTITUTIONAL CONSTRUCTION OF FACILITIES PROJECTS - FY 1983

	PROGRAM PLAN	CCE	STATUS
o REHAB HVAC SYSTEMS (320)	245,000	245,000	A/E SELECTION PROCESS
o INSTALL ECONOMIZERS ON BOILERS	350,000	350,000	A/E SELECTED FOR PER
o AUTO. BLDG. OPER.-ENERGY MGMT.PH. IV	495,000	495,000	A/E SELECTION PROCESS
o REPAIR ELECTRICAL FEEDER # 3	225,000	225,000	A/E SELECTION PROCESS
o REPAIR ASPHALT ROADS & PARKING LOTS	490,000	490,000	A/E SELECTION PROCESS
o REPAIR FIRE WATER TOWER	190,000	190,000	A/E SELECTION PROCESS
TOTAL INSTITUTIONAL	1,995,000	1,995,000	

MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS MICHOUD ASSEMBLY FACILITY SB01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 12 DATE FEBRUARY 13, 1982 SPEAKER MATHIAS P. SIEBEL

INSTITUTIONAL CONSTRUCTION OF FACILITIES PROJECTS - FY 1984

	PROGRAM PLAN	CCE	STATUS
o REHAB OF ENG. OFFICE BLDG. (102)	5,000,000		BUDGETARY SUBMITTAL
o REHAB HEATING & COOLING COILS, CELLS B & C (110)	440,000		BUDGETARY SUBMITTAL
o REPAIR UNDERGROUND COOLING WATER LINES	240,000		BUDGETARY SUBMITTAL
o MODIFICATION TO BARGE DOCK (480)	1,070,000		BUDGETARY SUBMITTAL
o REPLACE STEAM BOILER	795,000		BUDGETARY SUBMITTAL
o REHAB & MOD OF STORM DRAIN.SYST.(088)	1,610,000		BUDGETARY SUBMITTAL
o HEAT RECLAMATION OF DESICCANT UNITS, CELLS B-C/G-H (110/114)	780,000		BUDGETARY SUBMITTAL
o REHAB FIRE ALARM SYSTEM	485,000		BUDGETARY SUBMITTAL
o REHAB SUBSTATIONS W/ HIGH SIDE FUSES	140,000		BUDGETARY SUBMITTAL
o REPAIR UNDER SLAB CHEMICAL WASTE LINES	265,000		BUDGETARY SUBMITTAL
o REPAIR ELECTRICAL FEEDERS #1 and #5	300,000		BUDGETARY SUBMITTAL
o REPAIR 60-INCH STORM DRAIN LINE	440,000		BUDGETARY SUBMITTAL
o REPAIR ASPHALT ROADS & PARKING LOTS	200,000		BUDGETARY SUBMITTAL
TOTAL INSTITUTIONAL	11,765,000		

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MARSHALL SPACE FLIGHT CENTER SHUTTLE PROJECTS SM01	MICHOUD ASSEMBLY FACILITY OVERVIEW	NO. 13 DATE Feb. 13, 1982 SPEAKER Mathias P. Siebel

SUMMARY

The Michoud Assembly Facility

- Accommodates NASA/MSFC Programs and Activities of Other Agencies
- Is a Strategically Located Major and Diversified Industrial Complex
- Has a Proven Management Mode and Performance
- Has Major Economic Impact in the Region

In The Future MAF

- Will Enhance MSFC's Posture for Major Assignments in New Programs

NASA-MSFC-MAF SP-PC-003 (OT) (OCT 77)

unknown amount, approximating 27 per year. Then additional moneys would be needed, as shown in the lower right-hand corner where facilities would need another approximately $50 million to go on to the full rate of 55 per year.

The tooling breaks down into structures, and assembly at about $65 million. The thermal protection system additional tooling at about $75 million. Transportation and handling equipment is about $40 million on things like the turnaround tools for the shipment to the Kennedy Space Center, Vandenberg Air Force Base. Vendors represent an additional investment requirement on tooling; and that figure will settle down as we negotiate with the vendors on their contribution to the program, their own investments that they would make versus those that we would have to secure funding for specialized tooling for the program unique items. We can support the maximum planned launch rate of 24 per year, and we're working very hard toward meeting the ultimate rate of 55 per year, but we're concentrating presently on cost reductions and cost reductions through productivity.

We have three major programs directly related to productivity and an additional one indirectly related. The additional one is the quality of worklife work that we're doing. The productivity improvements are from our production readiness work. That has to do with things like making the work station at the assembly are more efficient with better tooling, more tooling available to the worker and available to him by having racks on which all the required tooling is hanging and coded to indicate if a tool is not there at the start of a shift, it's readily apparent. Those items will increase productivity. The second area of productivity is where we would have to make an engineering change, crossing an interface where a change that we would recommend for external tank reduction in cost would have to go level III, level II, and level I for approval to make the change. That's largely in the Dick Foll generated engineering area where they can come up with new designs which would reduce the cost of the tank. The major area that we're working on is in producibility assessment where we have a formal effort well documented and a commitment made that we will reduce the cost of the first 54 production tanks. That's the 60th tank off, the first 54 tanks we would reduce that cost by $66 million; and, and you can see from the first two blocks, we're making fine progress on that. In 1980 we had a plan of $2 million in savings due and we achieved $1½ million. In 1981, we've gone over the goal of achievement, and we expect to stay on course and achieve the $66 million in reduction on those 54 first production tanks. Tracing down the curve, that results at the end of the line with a significant program saving, depending on the mission model used, and depending on the inflation assumed; but it is the $1½ billion range at program run out under the mission plan, as we see it today. It could be as high with inflation as roughly $66 million and could be extrapolated to a savings for the program of $857 million with assumed inflation rates. The curve has two steps in it. The first one is based on program assumption that the ice and debris work will be reduced at that time. The second step is the range safety system will be eliminated at that time.

In the area in which, Mr. Chairman, your committee often asks us and that's the stability of our work force. I would like to report that we have a stable and well-trained work force. Currently at the Michoud assembly facility we have 3,461 employees. During the year 1981, we hired 1,405 new employees. We hired and trained approximately 728 hourly employees in 1981. That training resulted in our identification of those workers that we felt would not meet the standards that we wanted. By that process we reduced approximately 110 of those new hires through the euphemism, involuntary termination. We discontinued their employment because we didn't feel they were going to meet our standards. Even with that, we have a below Aircraft Industries Association average on attrition, and we do have those data which support the fact that this is a stable, well-trained work force with a ready source of employees in the New Orleans area.

In the quality work life area that I mentioned, one of the main things we do under the heading of system refinement teams—that is our name for quality circles—the data there shows you the number of teams we have, number of participants, and some of the quantity of programs they have suggested for improvement. We do not track that on the basis of cost savings suggestions or productivity increases. We do not make a direct measure of their output. We rather would reflect what the quality circles mean to us in the way of a different attitude of the work force and better performance of the work force.

The first group of percentages is a comparison of the members on SRT's with those employees who are not systems refinement team members. On things like lost time, grievances, MARS, those are significant percentages of reduction by those employees who are participating. Further, to measure the accuracy of those figures, we ran some data on the employees who are in quality circle work and who were measured before they joined the teams and after they joined the teams, and those figures of merit are impressive. Those are the same people before and after joining the team,and it does to me reflect the different attitudes by the people and in their performance on the job. Those figures that are measured are, of course, important for production of productivity and in keeping the cost of the tank lower, and it further demonstrates the stability of the work force.

Congressman FLIPPO. Ken, the chart just before that one and in the attrition chart——

Mr. TIMMONS. Yes, sir.

Congressman FLIPPO. In 1977 you had 26.7 percent total. You went to 13.9 in some areas like hourly 55.8 to 70.7. That's rather impressive. You attribute most of that to the quality control or management attitude?

Mr. TIMMONS. No.

Congressman FLIPPO. What do you attribute it to?

Mr. TIMMONS. I think management attitude, its attention to the work force, but it also represents successful union negotiations, higher labor rates, more competitive in the area. It is impressive coming off that grteater than 50 percent annual attrition, the hourly work rates, the hourly work force of 1977. It's the result of a lot of attention to what we considered area difficulty, and the sta-

tistics indicate that we have solved the area difficulty because you see in the center of charts there, the New Orleans area average in the manufacturing trades has been running over 50 percent. It's 50 percent of the employees change jobs annually.

Congressman FLIPPO. You wouldn't be interested in taking on a large Government contract, would you?

Thank you.

Mr. TIMMONS. Had you any further questions on the attrition of the systems refinement teams, Mr. Chairman?

Congressman FUQUA. Very good.

Mr. TIMMONS. Then, in summary, two flight articles have flown successfully and very successfully.

The small disadvantaged work has been recognized, as I said, by the Defense Logistics Agency. We have a regional first place award and have been nominated for a national award in that area, and we're proud of being good contributors in an area which needs assistance; and that's the small disadvantaged.

Cost per flight growth by the external tank has been proportional to overall program growth while accepting significant requirement changes, and some of those from other program elements.

Production rate of 24 tanks per year can be achieved as required by NASA and furure growth of the maximum mission model rates required by NASA can be accommodated at this facility.

Productivity has been increased through programs, as I said, of producibility, production readiness, and the quality of work life programs.

Funding requirements continue to be well coordinated due to the NASA program office, and we have met the prior year funding marks with precision each year. The final thing, mission success still remains our important product at Michoud.

Evan, I would like to set up the tape and present to you a 14-minute tape on some of those productivity items that we have been working on, and that would be ahead of a tour of the planet. I will be available to answer questions after the tape.

[A tape entitled "Space Shuttle External Tank Production" was shown which ran 15 minutes.]

Mr. TIMMONS. Many of the items shown there will be available to you on your tour; and, of course, pending your desires, all of them could be made available to show you.

This concludes the planned presentation we had here, and my associates and I will be happy to answer any questions you may have.

Congressman FLIPPO. Ken, do you fabricate all three sections of that tank here in your facility?

Mr. TIMMONS. Yes we did, the weldments of the main hydrogen, LOX tank and the intertanks are assembled here. It's assembled at this facility. Very little metal machining is down here. We buy the components, bring them in, and assemble them here. All three major segments of the tank.

Congressman FLIPPO. The components, do you plan any changes in the acquisition of components?

Mr. TIMMONS. You mean for a source of supply? Yes, we have some dual sources being investigated. Most of them are presently on fixed price contracts with the facility having made an investment in the program. Many of the major supplies will come from

the same areas, but we are investigating alternative sources and dual sources.

Mr. LINDSTROM. Mr. Chairman, we have considered a plan which would move the intertank out of this facility and recommended such a plan to NASA headquarters. There are two reasons for doing this. One was to free up valuable space in this facility in 103, which is the main manufacturing building, and also the potential downstream of gaining competition, as we view competition, one means of lower costs, as Ken does; and, of course, procuring components. They emphasize competition, and we have that under consideration.

Congressman FUQUA. How about batch supplies?

Mr. LINDSTROM. We do hope and have discussed with Martin Marietta a major buy so that we can then go to their subcontractors and vendors and procure a larger number of components and hopefully get a lower price and also get the vendor to commit capital for providing him tooling facilities for his components. We're thinking in terms of possibly something on the order of 30 tanks or so on our next contract with the Martin Marietta Co. We've started those discussions, and we'll be working with NASA headquarters. As I indicated yesterday, we're looking at the same thing for the solid rocket components.

Mr. TIMMONS. We're aware, Mr. Chairman, of the Marshall desire to move the intertank to a different location. Our plan is to retain it here. We are planning our tooling, and we believe retention here is cost effective for the program.

Congressman FUQUA. Could you continue on the rate of say around 30 or 35 a year, have enough room to make the intertank here?

Mr. TIMMONS. In all the layouts that we do the intertank is an integral part of the flow and space utilization.

Congressman FUQUA. So space is not really a critical problem at that rate?

Mr. TIMMONS. The final limiter at the top of that curve where we showed it bending at about 55 per year is traffic flow being the ultimate limiter, not square footage.

Congressman FUQUA. For all three components?

Mr. TIMMONS. Yes, but that is in the very high rate of 55 per year.

Congressman FLIPPO. Ken, before we leave here I know the chairman joins me in thanking everyone for giving up their Saturday morning.

Congressman FUQUA. Yes.

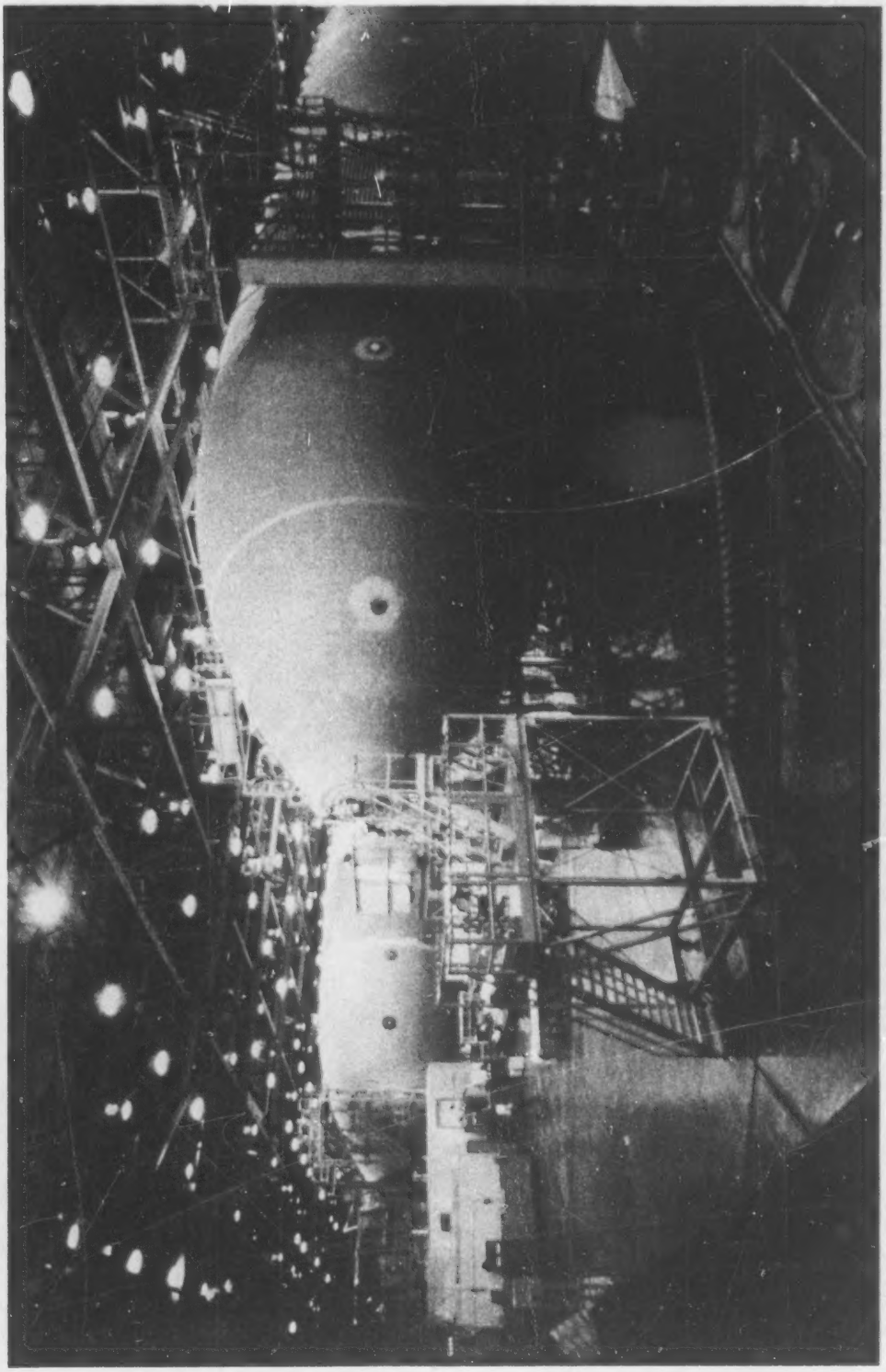
Congressman FLIPPO. That tells you something about management attitude here, too, I guess.

Mr. TIMMONS. Happy to do it. Are you ready for the tour?

[Figures to Mr. Timmons oral presentation follow:]

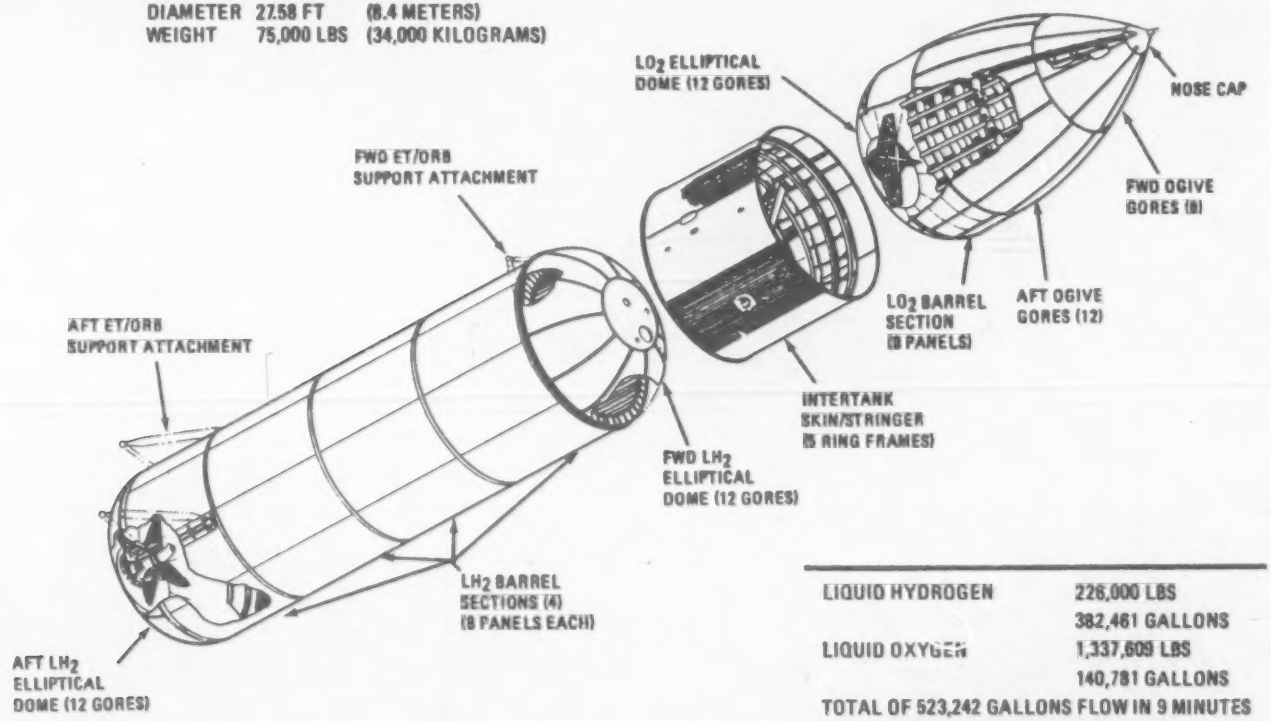
Subcommittee On
Space Science And Applications
Of The
Committee On Science And Technology
U.S. House Of Representatives

650



Space Shuttle External Tank

LENGTH	153.68 FT	(47 METERS)
DIAMETER	27.58 FT	(8.4 METERS)
WEIGHT	75,000 LBS	(34,000 KILOGRAMS)


LO_2 ELLIPTICAL DOME (12 GORES)
NOSE CAP
FWD ET/ORB SUPPORT ATTACHMENT
FWD OGIVE GORES (8)
LO_2 BARREL SECTION (8 PANELS)
AFT OGIVE GORES (12)
AFT ET/ORB SUPPORT ATTACHMENT
INTERTANK SKIN/STRINGER (5 RING FRAMES)
FWD LH_2 ELLIPTICAL DOME (12 GORES)
LH_2 BARREL SECTIONS (4) (8 PANELS EACH)
AFT LH_2 ELLIPTICAL DOME (12 GORES)

LIQUID HYDROGEN	226,000 LBS 382,461 GALLONS
LIQUID OXYGEN	1,337,609 LBS 140,781 GALLONS

TOTAL OF 523,242 GALLONS FLOW IN 9 MINUTES

TOTAL OF 36,126 INCHES OF WELD (OVER ONE-HALF MILE)

Flight Article Status

EACH OF THE FLOWN EXTERNAL TANKS WERE EXTREMELY SUCCESSFUL. TWO TANKS ARE NOW AT KENNEDY SPACE CENTER AND BEING READIED FOR LAUNCH OPERATIONS. ALL OF THE TANKS CURRENTLY IN PRODUCTION AT MAF ARE ON OR AHEAD OF SCHEDULE ACCORDING TO NASA POP 81-2X4 REQUIREMENTS.

Small & Minority Business Status As Of 12/31/81

	TOTAL APPLICABLE	AWARDED	PERCENT
• SMALL BUSINESS			
PROCUREMENTS	147,557	112,474	76.2%
VALUE	$412,506,119	$195,240,827	47.3%
• MINORITY BUSINESS			
VALUE OF OPPORTUNITIES TO BID		$ 15,031,202	
NUMBER OF AWARDS		2,450	
VALUE OF AWARDS		$ 6,043,303	

SBA/DCAS RATING "EXCELLENT"

Cost Per Flight History

SINCE THE BASIC PROPOSAL NEGOTIATIONS IN LATE 1974, THE AVERAGE PROJECTED COST PER ET HAS INCREASED BECAUSE OF:

- ADDED WORK SCOPE FROM REQUIREMENTS CHANGES
- DEVELOPMENT EXPERIENCE
- SHIFTING (DELAYS) IN PRODUCTION MISSION MODEL
- INFLATION ABOVE PREVIOUSLY NEGOTIATED RATES

Flight Article Status-As Of January 22,1982

ET-1 ——— FLOWN

ET-2 ——— FLOWN

ET-3 ——— MATED AT KSC FOR MARCH LAUNCH

ET-4 ——— ERECTED AT KSC - IN CHECKOUT

ET-5 ——— IN FINAL ASSEMBLY - SCHEDULED FOR MAY 26 DELIVERY

ET-6 ——— IN FINAL ASSEMBLY

LWT-1 ——— TPS BEING APPLIED TO INTERTANK, LO_2 TANK AND LH_2 TANK

LWT-2 ——— TPS BEING APPLIED TO INTERTANK, LO_2 AND LH_2 TANK IN PROOF TEST

LWT-3 ——— INTERTANK IN ASSEMBLY. LO_2 AND LH_2 TANKS IN MAJOR WELD

LWT-4 ——— LO_2 AND LH_2 TANK DOMES/BARRELS IN PANEL TRIM AND WELD

Small/Small Disadvantaged And Minority Business Performance

- OUR SMALL/SMALL DISADVANTAGED AND MINORITY BUSINESS PROGRAM HAS CONTINUOUSLY RECEIVED THE HIGHEST RATING POSSIBLE - "EXCELLENT" - AS A RESULT OF QUARTERLY AUDITS BY DCAS AND SBA.

- IN CY 1981, 53.1% OF PROCUREMENTS WERE MADE FROM SMALL/SMALL DISADVANTAGED BUSINESS AND MINORITY FIRMS, WHICH WAS A NEW RECORD FOR THE MICHOUD DIVISION. PERFORMANCE ON THE TOTAL PROGRAM TO DATE HAS BEEN 47.3%.

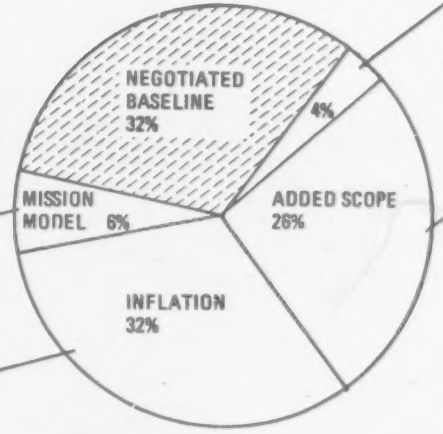
- FINAL EVALUATION OF PERFORMANCE TO THE CY 1980 GOALS, COMPLETED IN DECEMBER 1981, RESULTED IN A NOMINATION BY DCAS TO RECEIVE SPECIAL RECOGNITION UNDER THE DEFENSE LOGISTIC AGENCY MOTIVATION PROGRAM. ADDITIONAL FEE IN THE AMOUNT OF $243,198 WAS AWARDED.

Cost Per Flight History

COST PER FLIGHT ~ 75 $

	1976	1980
ET-MMC	2.55	4.15
%	15.9	15.8

CURRENT YEAR (1981 $)
ET-MMC 8.674



EXPERIENCE

- TPS GROWTH-HIGHLY DEVELOPMENTAL
- SUPPORT LABOR FACTORS INCREASED
- MATERIAL & SUBCONTRACT (GBL)

ADDED SCOPE

ORBITER

- ICE DEBRIS
- ICE ON PROTUBERANCES
- LWT
- LO_2 ECO SENSORS

ENVIRONMENTAL

- 1974 FLIGHT LOADS
- AERO HEATING REQUIREMENTS
- PROTUBERANCE AIRLOADS

OTHER

- IT MATERIAL SUBSTITUTION
- RANGE SAFETY

MISSION MODEL

4½ YEAR MID POINT SHIFT

INFLATION

CONTRACT NEGOTIATED AT 5% ESCALATION HOWEVER, 7 OF PAST 11 YEARS EXPERIENCED DOUBLE DIGIT INFLATION.

Facility Background

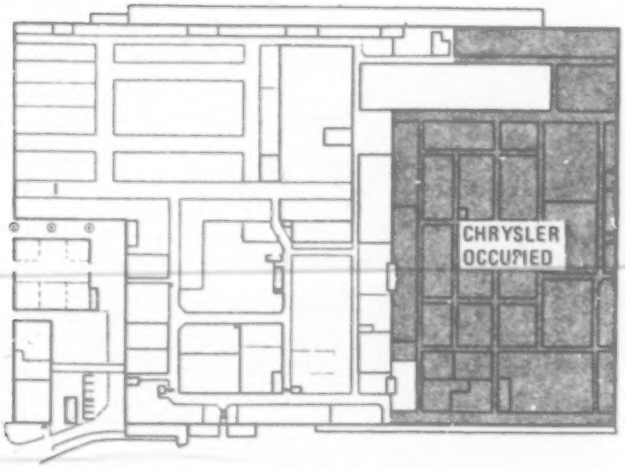
- EXTERNAL TANK PROGRAM START-UP AT MAF CONSIDERABLY INFLUENCED THE CURRENT LAYOUT AND OPTIMUM MANUFACTURING LAYOUT CONFIGURATION.
  - INITIALLY THE SATURN S-1C (WEST SIDE) OF BUILDING 103 WAS ONLY AREA AVAILABLE
  - CONSIDERABLE SATURN PROPERTY, FACILITIES AND EQUIPMENT REQUIRED REMOVAL, INVENTORY AND DISPOSITION

- A THROUGH-AISLE, PLANNED EARLY IN THE PROGRAM WILL SMOOTH THE ELEMENT FLOW
  - REDUCES DOLLY MOVES PER ET FROM 101 TO 38
  - RE-ROUTE 21 MOVES THRU 1 SINGLE AISLE TO 6, 6 & 3 THRU 3 AISLES RESPECTIVELY
  - REDUCES MAJOR BACKFLOWS FROM 9 TO 3
  - PROVIDES 10 QUEUING POSITIONS AND 92,000 SQ. FT. OF IN-PROCESS STORAGE

- THE FACTORY FLOW BASIC LAYOUT FOR 24/YR WAS CONFIRMED BY S & P REVIEW

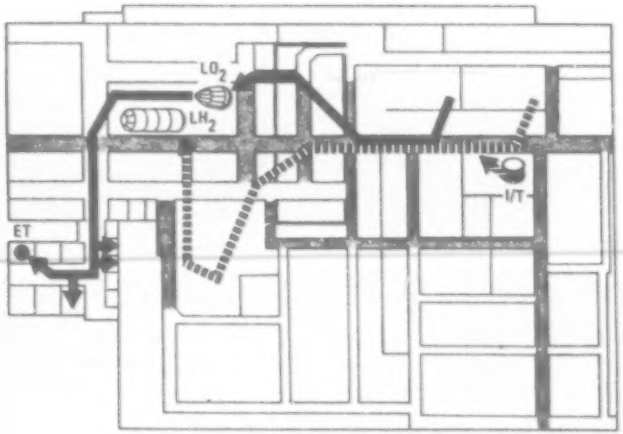
Background

WAS



INITIAL LAYOUT IN LATE 1973

NOW



- SEGREGATES MAJOR COMPONENT FLOW
- RELIEVES TRAFFIC CONGESTION
- MAXIMIZES USE OF CRANE SYSTEMS
- PROVIDES IN PROCESS STAGING/STORAGE AREAS

Construction Of Facilities

REQUESTS FOR A NUMBER OF MODIFICATIONS AND NEW CONSTRUCTION FACILITIES HAVE BEEN SUBMITTED TO MSFC TO SUPPORT INCREASING EXTERNAL TANK PRODUCTION AT THE MICHOUD ASSEMBLY FACILITY.

CONGRESS HAS APPROVED THE FOLLOWING FY-82 C OF F PROJECTS:

ITEM	DESCRIPTION
1	MODIFICATION TO PATHWAYS, HARDPOINTS, PLATFORMS AND OTHER IMPROVEMENTS.
2	INSTALLATION OF NEW EQUIPMENT, REPAIRS TO THE BUILDING, MODIFICATIONS TO HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS FOR USE WHEN APPLYING PRIMER (DX1200) AND FOAM INSULATION (BX250).
3	PROVIDES TWO CONDENSATION RECOVERY UNITS WITH RELATED COMPONENTS.
4	ADDS FOUR FANS TO CIRCULATE HOT AIR IN THE VERTICAL ASSEMBLY BUILDING.

FY-83 C OF F PROJECTS SUBMITTED TO NASA HEADQUARTERS

ITEM	DESCRIPTION
1	PROVIDES CONTROLLED CLIMATES FOR PRIMING, SPRAYING AND STACKING TANKS.
2	PROVIDES SPACE AND EQUIPMENT FOR USE WITH NEW NET MOLDING PROCESS.
3	ADDS 20,000 SQUARE FEET TO ENCLOSED AREA FOR MACHINING AND PROCESSING FOAM INSULATION.
4	ADDS A SECOND CRANE WITH 180' SPAN AND 172.5' CLEAR HEIGHT.
5	INCREASES CRANE CAPACITIES, CONNECTING PREVIOUSLY SEGREGATED CRANE SYSTEMS.
6	CONTROLS CLIMATES FOR EACH HORIZONTAL POSITION OF THE TANK BY INSTALLING SIX PARTITIONS.
7	INCREASES MIX CAPACITY OF THERMAL PROTECTION SYSTEM BY ADDING TWO MIXERS AND RELOCATING INSTRUMENTS.
8	PROVIDES A WIDER MAIN AISLE FOR MOVING TANKS, RELOCATES X-RAY FACILITY, REALIGNS CRANES.
9	PROVIDE FULL-SCALE SPRAY FACILITIES FOR ABLATOR AND FOAM DEVELOPMENT FOR PRODUCTIVITY IMPROVEMENTS.

Construction of Facilities

- CONGRESS-APPROVED FY-82 C OF F PROJECTS

ITEM	TITLE	
1	ET-FINAL ACCEPTANCE AND PREP. TO SHIP, CELL-1 (420)	.5
2	BX-250 ENVIRONMENTAL CONTROL CELLS 1 & 2, (420)	2.6
3	CONDENSATE RECOVERY (103/110)	.2
4	AIR DISTRIBUTION SYSTEM (110)	.4
	DOLLARS IN MILLIONS TOTAL▶	3.7

- MARTIN MARIETTA FY-83 C OF F PROJECTS SUBMITTAL

ITEM	TITLE
1	HIGH BAY ADDITION, PHASE II CELLS "K" & "L" (114)
2	SLA COMPONENT MACHINING FACILITY
3	SOFI COMPONENT SPRAY & MACHINE FACILITY (103)
4	NEW CRANES, PHASE II VAB (110)
5	LH_2 TANK BRIDGE & HOIST MODIFICATIONS (103)
6	ENVIRONMENTAL CONTROL, HORIZONTAL INSTALLATION, POSITIONS 1, 2, 3, & 4 (103)
7	REHABILITATE TPS MIXER ROOM (103)
8	MODIFICATIONS FOR PRODUCTION FLOW
9	ADVANCED MFG. TECHNOLOGY FAC (103)

NOTE: FORWARDED TO NASA HEADQUARTERS BY MSFC

MAF Production Capacity

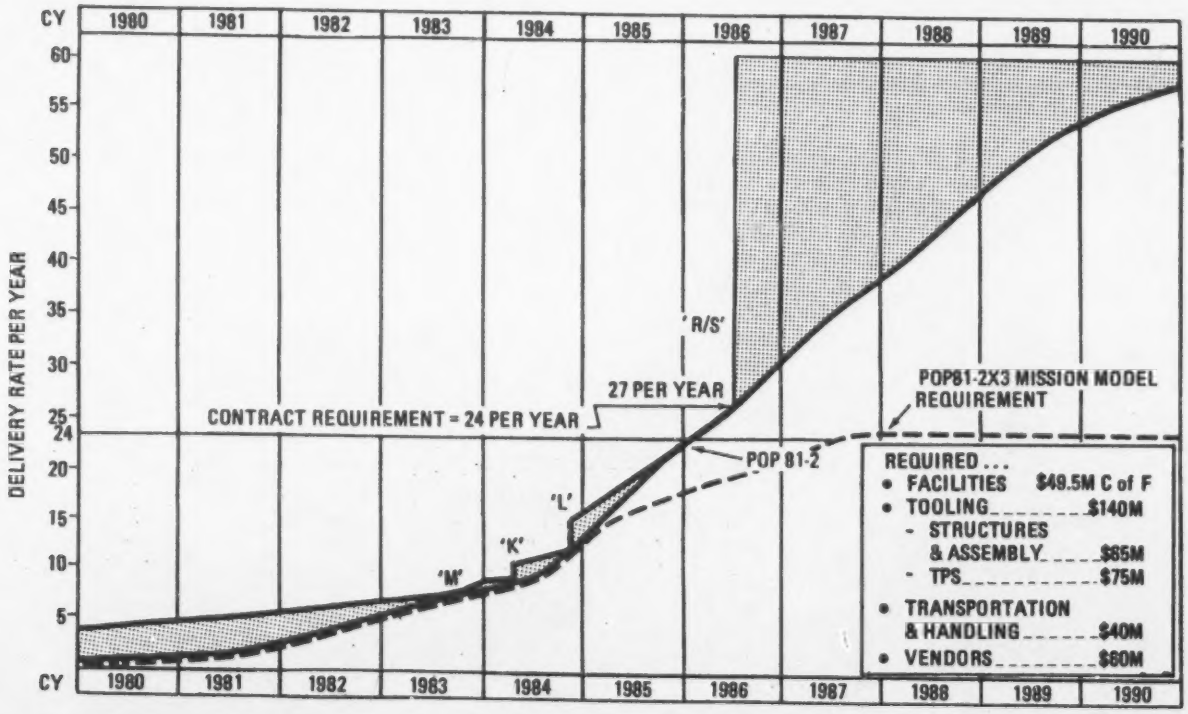
THERE ARE THREE MAJOR FACILITY PROJECTS (CELLS) WHICH WILL STEP UP THE PRODUCTION RATE TO 24 TANKS PER YEAR BY 1986.

THEY ARE:

1. CELL M - ON LINE OCT., 1983 FOR LH_2 SLA SPRAY
2. CELL K - ON LINE APRIL, 1984 FOR LO_2/INTERTANK SLA SPRAY
3. CELL L - ON LINE NOV., 1984 FOR LO_2/INTERTANK SOFI SPRAY

WITH THE ADDITION OF TWO OTHER CELLS TO BE ON-LINE BY JUNE, 1986 PRODUCTION CAN BE INCREASED TO APPROXIMATELY 55 EXTERNAL TANKS PER YEAR IN THE LATES 1980'S.

MAF Production Capacity



Cost Reduction-Productivity Program

THE MARTIN MARIETTA COST REDUCTION APPROACH IS MADE UP OF THREE DISTINCT AREAS:

1. PRODUCIBILITY ASSESSMENT & PROGRAM (PAP)

   COST REDUCTION CANDIDATES ARE SCREENED, ASSESSED, RECOMMENDED FOR DEVELOPMENT OR IMPLEMENTATION (IMPLEMENTATION WITH MSFC APPROVAL ONLY).

2. PRODUCTION READINESS PROGRAMS (PRP)

   ACTION IS TAKEN PRIMARILY TO ACHIEVE RATE AND IMPROVE PRODUCTIVITY TO REDUCE COST.

3. PRODUCIBILITY ENGINEERING PROGRAM (PEP)

   DRAWINGS ARE REVIEWED FOR ALTERNATIVE DESIGNS TO REDUCE COSTS AND SPEED PRODUCTION

Cost Reduction-Productivity Program

- 1980 COMMITTMENT

  REDUCE COST OF FIRST 54 PRODUCTION TANKS BY 66 M $ FOR NON-RECURRING COST OF 20 M $

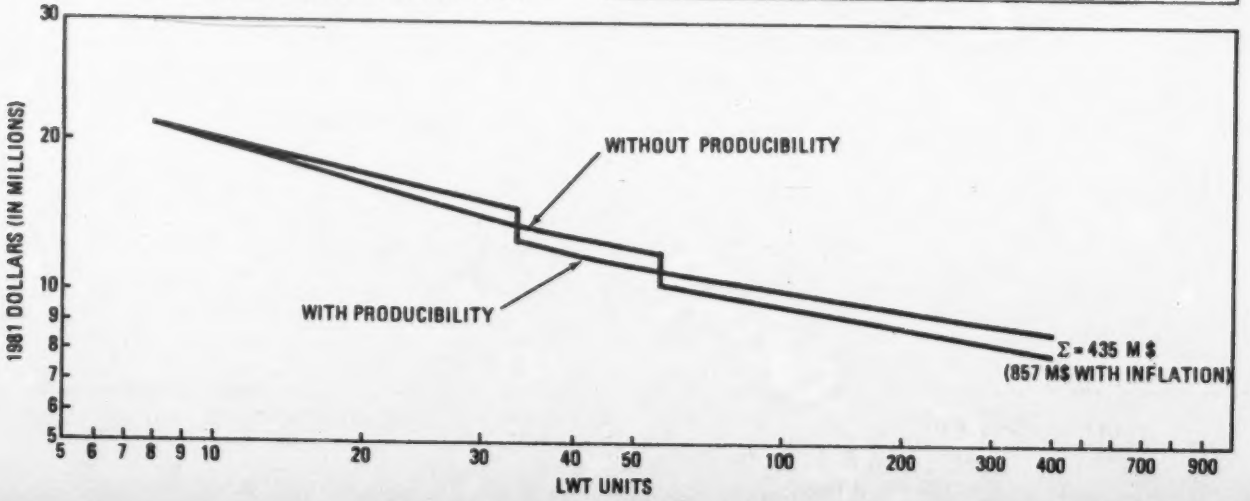
- IMPLEMENTATION

CY	1980	1981	1982	1983	TOTAL
PLAN	2.0	15	32	17	66 M $
ACTUAL	1.5	16.6	-	-	

- FUTURE
  - IN PROCESS OF CHANGE FROM CPAF TO CPIF

COST REDUCTION EXAMPLES

- ROUGH MACHINING LH_2 PLATE AT MILL
- REPLACE SAND CASTING WITH INVESTMENT CASTING FOR TITANIUM FITTINGS
- REPLACE MOLD/MACHINE WITH SLA NET MOLD
- AUTOMATIC INSPECTION FOR WELD PEAKING AND MISMATCH
- AUTOMATIC WELD NDE "ALL UP" SYSTEM
- REPLACE SLA/SOFI WITH NEW SOFI FOR AFT DOME
- REDUCE SIZE OF LO_2 SLOSH BAFFLE
- RETURN LO_2 SENSORS TO ORBITER



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Work Force Stability

THE PERTINENT ELEMENT OF THE MARTIN MARIETTA'S 1981 WORKFORCE AND GROWTH EXPERIENCE WAS A 72.1% INCREASE IN OUR HOURLY WORKFORCE. THIS GROWTH WAS CHARACTERIZED BY THE ACQUISITION OF SKILLED LEVELS MORE COMMENSURATE WITH VOLUME PRODUCTION. OVER THE COURSE OF THE YEAR, THE SKILLED DISTRIBUTION WAS REALIGNED AS LISTED BELOW:

	1/1/81	12/31/81
SKILLED	31.2	23.5
SEMI-SKILLED	39.9	34.0
OPERATIVE	28.9	42.5

213 HOURLY EMPLOYEES TERMINATED DURING 1981. 110 OR 51.6% WERE FOR INVOLUNTARY REASONS. THIS DEMONSTRATES A CONCERTED EFFORT ON THE PART OF MARTIN MARIETTA TO EVALUATE AND SELECTIVELY RETAIN PRODUCTIVE AND ADAPTABLE EMPLOYEES.

OVERALL, THIS ANALYSIS INDICATES THAT MARTIN MARIETTA HAS AN EXTREMELY GOOD RECORD OF RETAINING HIGH SKILLED, LONG TERM EMPLOYEES.

FIELD HEARINGS

MONDAY, FEBRUARY 15, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Johnson Space Center, Houston, Tex.

Dr. KRAFT. A lot of good things have happened since the last time we had hearings. We are pretty proud of all that has happened, of course, as you are.

The first and second flights of the Space Shuttle are certainly great milestones in the history of this business. It is my opinion that the Space Shuttle is probably the most complex machine that has been built by man. Certainly there are bigger ones and more costly ones, but I do not know of any that is as sophisticated as that machine. I think that is a really great tribute to the industry of our country. I think that it will probably have a more profound effect on the development of flying machines than most of us would realize. An electronically controlled airplane is very much on the minds of the commercial airplane builders in this country. I believe that the next generation of commercial transports will take advantage of the Shuttle results and totally fly by wire.

The B-1 right now is faced with a tough decision, because every airplane built by the U.S. Government requires what pilots call manual reversion. That means that if all of the autopilots break and everything else breaks you still have the capability of flying the machine with the mechanical linkage between the stick and the controls. That is becoming more and more impractical. It is my opinion that in most of the fighter airplanes that still have manual reversion, if the pilots were ever faced with having to use it they could not control the airplane anyway. The whole Government structure dealing with safety and airplane design is going to have to review all that, and I think the Space Shuttle results will have a great deal to play in justifying the engineering facts that you can eliminate manual reversion.

That decision will have a profound effect on flying machines. Once you accept the fact that you are willing to fly totally by wire rather than by cable; then there is a lot of redesigning you can do to take advantage of the size of the control surfaces. This affects the size of the airplane relative to the wing size and the control size, ailerons, rudders, and fins. This can have a profound effect on the efficiency as you can make airplanes smaller. I think that is where we are going in the future.

The Space Shuttle really has a great deal more going for it than at first meets the eye. I believe it was a tremendous accomplish-

ment by our industry. Of course, the Government team had a big part to play in it, but I think you have to give the credit to the American industry and people that were able to build it.

We have with us this morning Dr. Lunney, who took Bob Thompson's place. I would like to say that for the record. You gentlemen already know it, and you know Dr. Lunney and his capabilities. He has been with the program from the beginning, like many of us who have spent our entire career with the Government. I will say a little bit more about this aspect in a few minutes, but Dr. Lunney is a super guy that I know you know very well. He has done a super job since taking over for Mr. Thompson.

Jerry Bostick is one of his assistants who deals mostly with the operations of the Space Shuttle in the future and with our customers. Mr. Charlesworth, who is the deputy director here is also a long-term player with us in space flight. Mr. Loftus is going to speak to you on our advanced development. Al Louviere has been working on a space operations center for a long time and is one of our leading people in the engineering and development directorate. Mr. Nicholson is involved in operations and planning for the coming use of the Space Shuttle. He will work with me for 4–6 months. I try to bring some of our best people up to work with my staff for about 3 or 4 months at a time so they get a feel for some of the crazy things that we have to do at this center. Mr. Abbey is here this morning. Mr. Clements, you know, who is the associate director here and over here is Mr. Cohen who is the program manager for the orbiter and next to him is Mr. Aldrich, who is deputy to Dr. Lunney.

That is an opportune time for me to say that we read in Aviation Week and in Aeronautics and Astronautics that we here at the Johnson Space Center have an R. & D. base and that we have to get rid of that R. & D. thought if we are ever going to get into an operational mode with the Space Shuttle. We find that a very interesting thought process. Between the few of us that you have seen, myself, Dr. Lunney, Mr. Aldrich, Mr. Charlesworth, Mr. Abbey, and Mr. Clements, probably have more experience in space flight operations than anyone in the free world and probably in the world.

Why you would want to get rid of that group is beyond our comprehension. We find this viewpoint, that we do not have an operational base, rather interesting. If you are going to turn this think into an operational vehicle you have got to be careful how you get rid of all those experienced operational people or you will turn it over to people who have no experience with space flight operations.

Congressman FLIPPO. Dr. Kraft, we do read a lot of those things in Aviation Week, those things that is hard to pin down, but I think this committee has a long history to support and is in great appreciation of the experience of those individuals and the entire team here at Johnson.

Dr. KRAFT. Yes, sir. I'm well aware of that and I just thought I'd take the opportunity to put in on public record. It's one of those kinds of things that you read about that are rather disturbing to a group of people that we have within Government these days. We, over the last few months, have lost a lot of good experienced people. Dr. Max Faget, Bob Thompson, Aleck Bond, and others that

have retired since the first flight. We are coming to an era where a number of us are probably going to retire in the not too distant future. We have built up not only at the Johnson Space Center but at Marshall and KSC a real base of people. We have given them good experience and I think that we've got a group of young men that can take the place of those leaders that we've lost. I think we are in reasonably good shape. As you well know, we have a group of people who are really dedicated and believe in what they're doing.

I think you also know the problems that face the Government servant today. In terms of salaries, the merit-pay situation, and the whole limits of the senior executive service. In our opinion, and I don't say this with any bitterness, these things are deincentivising rather than incentivising. As an example, two of my employees, I don't know whether we sent you a copy of that letter or not, Ronnie, you and Don both, but two of my best employees wrote letters about the situation. They didn't write to complain, because they aren't going to leave. They wrote to explain their situation in the merit pay system. Because they were in merit pay, they ended up getting less money than the people who worked for them. This was a result of the new set of regulations that we're dealing with. They wanted people to understand that they had no intention of leaving, but they wanted known, what they're having to deal with. We do have that concern about the morale of our people. These things they read in all the magazines about operations, et cetera, are rather incongruous to them. It is morale problem. If we're going to maintain the successes that we've had, it can only be done through a group that is committed and has high a morale factor because the success we have had depends on that kind of people.

I don't think you can continue to have the type of success that this country can show the entire world without having that kind of thought process. If you leave it to the normal production worker in the plant. You're not going to get that kind of success—Glynn and I both have talked about this a lot. We try to think, what keeps our people inspired? Frankly, I don't know what it is. If I knew how to put my finger on it, it would be super. I don't think anybody quite knows what it is. It can get away from you just as easily as you can achieve it.

Congressman FUQUA. I knew a former newspaperman who later became dean of the journalism school and one of his favorite sayings was, if he couldn't walk around the block and get something to write a feature story about, you know, then he was not a very good newspaperman, so you find them somethings straining at gnats in order to write these type of things, and I don't think that that is a serious thought at this time. Sometime in the future we may have to move space shuttle into operational type thing, but it's a long way away, in my opinion, before that happens and a lot of bridges to be crossed.

Dr. KRAFT. Yes.

Congressman FUQUA. And people talk about it and any time you have anything that's good, somebody is going to want it and if it's not any good, they run the other way so people will come and try to say, this is what we need. This is in the national interest to do

that only because it works and it's good and you've done your job, so that always happens too.

Dr. KRAFT. The problem is that we cannot say, this is a horribly complex machine. It takes a great deal of preparation and a lot of work by a lot of dedicated people. If people hear that, the first thing you know they're going to say; we better not touch that thing. We don't want to give the impression that this is a difficult machine to operate, but the truth of the matter is, it is a complex machine. It takes people who understand it to deal with it.

It's sort of like the guys that just got through running at the Daytona 500. They understand the problems, and they know what they're walking into when they get in that machine. They know what they're going to be faced with when they put it on the track. They wouldn't put you or I in one of those machines and expect us to drive around there and win the race.

Congressman FUQUA. I hope not, Dr. Kraft.

Dr. KRAFT. It's sort of an enigma, if you will, because we don't want to make this thing sound so complex that it can't be operated. We're proud of what has happened in the last 2 years, but we've got three flights to fly this year. We're looking forward to the first flight of commercial value to us in the STS-5 with two satellites that we're going to put up. We're looking forward to the delivery of the second vehicle, OV-099 and we're pleased with the work that Rockwell had done to deliver that machine on schedule. We can't say too much for that. We think that 103 and 104, the third and fourth vehicles, are doing extremely well. The contractor had a lot of problems initially because they laid off a lot of people and had to rebuild the learning process. We think we've got the pipeline going and we're ready to go into the operational phase of the program.

As Congressman Fuqua has said, that's not going to take place overnight. We've got a lot of things to put into the early flights. It will take us 20 flights or so to get all of the equipment developed and put into the machines in such a manner that we do indeed have an operating system. For instance, the KU band and the rendezvous radar will not be in until about the 10th or 12th flight.

We've got advancements in 103 over OV-099. You can only fly certain flights on orbiter 103 and orbiter 104 because of the weight reductions. So it's going to take us a while to get this airline going.

Surely, we're going to get there, but it's going to take a little longer than most of us think to get this machine operational, and that's as it should be.

We're doing a lot of other things at JSC with about 10 or 15 percent of our people. We still have a program in applications and planetary sciences, Earth resources and life sciences.

Our budgets are down like they are everywhere but we still have what we feel to be a viable program. Agristars is a combined program with the agricultural department, NOAA and the Department of the Interior. We've got a lot of good work going on and a lot of good people helping that program become a reality for a lot of other products as it was for ahcot.

The LACIE program [a large area crop inventory experiment] that we conducted is an operating program with the Department of Agriculture. They are very pleased with it and with being able to predict a lot of good things for agricultural products.

In flight experiments, for life sciences, we have seven on the first flight of Space lab. We have a dedicated life science program which we're going to have on Space lab 4. We've been looking for that for quite some time. The lunar sample program is, I think, sort of a forgotten world. We still have the Lunar Science Conference every year and we're going to have it again in March.

We do a lot of good work with the scientists in this country and around the world in developing information from the samples we brought back from the Moon.

Congressman FUQUA. Was not that zeroed out in the 1983 budget?

Dr. KRAFT. No, sir. I don't believe so.

Congressman FUQUA. I thought that was brought out by the lunar facility——

Dr. KRAFT. No, sir, I don't believe so.

Congressman FUQUA. OK. Where did I get that.

Mr. TATE. I don't believe that he's talking about that.

Mr. BRANSCOME. I think that's still a possibility.

Dr. KRAFT. The reason I bring it up is to make sure you realize we still have a program. It's about a $4 million program and a lot of good work has come out of it.

To be prefectly honest it's rather incongruous for us in this business to be plugging that. But I think a lot of good work comes out of that. A lot of work needs to be continued in that area because one of these days we are going back to the Moon and use it as an addition to the natural resources of this country.

In terms of advancements we think that the power extension package would be a very good extention of the capabilities of the Space Shuttle. It would allow us to stay up there as much as 30 days and develop enough power to run a lot of very good experiments, for ourselves and the Department of Defense.

We think that's still a viable program. We've done a lot of good work in the last year on the space station and what we call a Space Operations Center. We have published a lot of documents—not just a lot of verbal stuff—but documents we think are a strong base for the next program that we will start once budget capability is provided.

We think we can do a lot of good work in this year. General Abrahamson is doing his best to try to get some funds earmarked for the project as you probably know. If you don't know, he'll probably testify further on that. We believe there's a lot of good work that can be done by the industry on basic hardware and technology to allow us to be in a position to go forward with a space station of some kind at an earlier time by having had that work done.

I mentioned the manpower thing. We're still coming down in manpower as I've said to you almost every time you've been here. We're probably going to be around 3,230 or something like that by the end of 1982 and a little more in 1983.

Congressman FUQUA. How is that compared to contractors?

Dr. KRAFT. In numbers, we have about 5,500 and we're probably going to have a reduction there because of the budget.

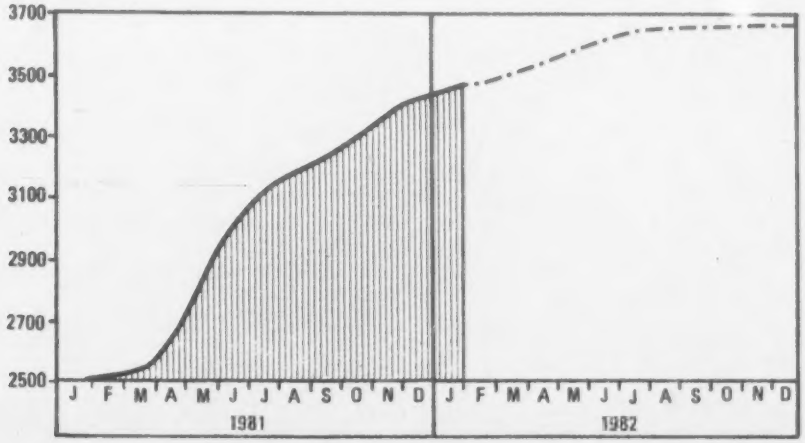
I'm still concerned about our ability to hire young men. We are just not able to hire as many as we'd like. Competition is tremendous in terms of salary structure, et cetera. However, I still think

People

ATTRITION

	1977	1978	1979	NEW ORLEANS AREA AVERAGE	1980	1981
EXEMPT SALARY	11.5%	16.6%	12.1%		10.6 %	11.5 %
NON EXEMPT SALARY	20.9%	23.0%	23.6%	50.0%	19.8 %	14.4 %
HOURLY	55.8%	37.5%	29.4%		17.7 %	20.8 %
TOTAL	26.7%	24.2%	19.0%		13.9 %	14.6 %

MICHOUD HEADCOUNT



Systems Refinements Teams-An Example Of Motivation Efforts Used

SYSTEMS REFINEMENT TEAMS (QUALITY CIRCLES) REPRESENT A PLANNED, ORGANIZED EFFORT TO CHANGE, IN A POSITIVE WAY, THE EFFECTIVENESS AND EFFICIENCY OF THE ORGANIZATION. THE GOAL OF THIS CHANGE IS PARTICIPATION BY EMPLOYEES IN DECISIONS AFFECTING THEIR IMMEDIATE WORK RESPONSIBILITIES. THE QUALITY OF THE CHANGE IS DEPENDENT ON THE COOPERATION OF MANAGEMENT, THE EFFECTIVENESS OF THE IMPLEMENTATION PLAN, AND THE PROFESSIONALISM, TALENT AND DEDICATION OF THOSE FACILITATING THE CHANGE. THE MAJOR PAYBACK FOR THIS EFFORT IS A PERMANENT, LONG TERM IMPACT ON THE ORGANIZATION AND ITS WORK FORCE STABILITY AND PRODUCTIVITY.

System Refinement Teams-Results

- NUMBER OF TEAMS

MARTIN MARIETTA	42-(478 MEMBERS)
MARTIN MARIETTA, NASA & DCAS	2-(32 MEMBERS)
OTHERS (AVCO & PAN AM-AHF IN TRAINING)	2-(18 MEMBERS)

- IMPROVEMENT PROJECTS COMPLETED/IN WORK - 125

- INDIRECT IMPACT

COMPARISON OF HOURLY SRT MEMBERS WITH HOURLY EMPLOYEES NOT YET PARTICIPATING REVEALED THE FOLLOWING SIGNIFICANT DIFFERENCES

- 44% LOWER RATE OF UNPAID LOST TIME FOR SRT MEMBERS
- 27% LOWER RATE OF GRIEVANCES FOR SRT MEMBERS
- 65% LOWER RATE OF SAFETY ACCIDENTS FOR SRT MEMBERS
- 42% LOWER RATE OF SAFETY INCIDENTS FOR SRT MEMBERS
- 76% LOWER RATE OF ATTITUDE RELATED ATTRITION FOR SRT MEMBERS

COMPARISON OF HOURLY EMPLOYEES 6 MONTHS BEFORE AND 6 MONTHS AFTER JOINING SYSTEMS REFINEMENT TEAMS INDICATED SIGNIFICANT IMPROVEMENTS

- 45% REDUCTION IN RATE OF UNPAID LOST TIME
- 58% REDUCTION IN RATE OF GRIEVANCES
- 57% REDUCTION IN RATE OF SAFETY ACCIDENTS
- 68% REDUCTION IN RATE OF SAFETY INCIDENTS
- 59% REDUCTION IN EMPLOYEE ATTRIBUTABLE HARDWARE NON-CONFORMANCES (MARS)

Summary

- TWO FLIGHT ARTICLES HAVE FLOWN SUCCESSFULLY, TWO ARE AT KSC BEING PREPARED FOR FLIGHT, AND SIX ARE IN ASSEMBLY AT MAF.
- SMALL/SMALL DISADVANTAGED AND MINORITY BUSINESS STATUS EARNED DEFENSE LOGISTICS AGENCY REGIONAL AWARD FOR EXCELLENCE AND NOMINATION FOR THE NATIONAL AWARD.
- COST-PER-FLIGHT GROWTH BY THE EXTERNAL TANK HAS BEEN PROPORTIONAL TO OVERALL PROGRAM GROWTH WHILE ACCEPTING SIGNIFICANT REQUIREMENTS CHANGES FROM OTHER PROGRAM ELEMENTS.
- A PRODUCTION RATE OF 24 TANKS PER YEAR CAN BE ACHIEVED AS REQUIRED BY 1987, AND FUTURE GROWTH TO THE MAXIMUM MISSION-MODEL RATES CAN BE ACCOMMODATED.
- PRODUCTIVITY HAS BEEN INCREASED THROUGH PROGRAMS OF PRODUCIBILITY, PRODUCTION READINESS AND "QUALITY OF WORK-LIFE" PROGRAMS.
- FUNDING REQUIREMENTS CONTINUE TO BE WELL COORDINATED WITH THE NASA PROGRAM OFFICE AND PRIOR-YEAR FUNDING MARKS HAVE BEEN MET WITH PRECISION.
- THE COMMITMENT TO MISSION SUCCESS REMAINS THE DOMINANT THEME AT MICHOUD.

that if we had the capability to hire, because of the strong commitment that we get from the young people in this country, I believe we would still hire very good people. We are disappointed that we cannot hire more young people than we do. We do reasonably well but we could do a lot better.

There is something I would like to say relative to the contractors. Not the local contractors but primes like Rockwell and its subcontractors. Mr. Cohen and I just spent 2 days with them this past week. We're not very popular out there. If we're going to get this program where we can afford it and get 103, 104, 105 and subsequent vehicle built for the money we are getting or hope to get then we're going to have to get the learning curve up and number of people down. That's a very difficult thing to do with Rockwell at this point in time.

They've built up a super staff in a number of areas, and are very reluctant to let those very competent people off their payroll. But that's what we're going to have to do if we're going to get the cost down. We've been spending considerable time analyzing what we can do to reduce the number of engineers on the program. Both with the contractor in California, their subcontractors, and the contractors that we have here. That's being done across the board in the overall Shuttle program. I imagine a lot of people will be reasonably unhappy with that, but we think it's necessary if we're going to get this thing more budgetarily conscious. In truth, we are at a place in the program where they ought to start coming down—we just can't keep engineering the thing forever.

So you may hear some reflection on that. Let me terminate and let Dr. Lunney get up here. I'll conclude by saying that we appreciate the association that we have with you gentlemen. We realize that your support is very important in getting our programs through the Congress. We appreciate you being here and your willingness to understand what our plans are.

Dr. Lunney? (Viewgraph A.)

Dr. LUNNEY. Thank you. I have an abbreviated version of the material which you have in your handout that I'll go through today. Perhaps as much as anything, the material is for purposes of just illuminating the scope of the program. You can stop any place you want and talk about it.

(Viewgraph A-1.) I will start with the organization chart because a couple of things have happened that I think are important to us. The only difference on this chart from the way it's been in the past is that we've combined the work that Jerry Bostick and I are doing.

If you recall, this is the Space Shuttle program office. There was another organization called STS Operations. We put those two organizations together. Aaron Cohen in the Space Shuttle orbiter project office is shown here in the traditional role of reporting programmatically through the program office. Of course, he and Chris are very much involved in day-to-day orbiter management. We combined the Space Shuttle—what was normally just the development office and added the work of the operations office. We expect that to work very well.

We were beginning to see a lot of problems with that as we changed from D.D.T. & E.

Congressman FUQUA. I understand you're going to do that at headquarters, too.

Dr. LUNNEY. Its probably time to do that.

There's another thing I would mention about this. It's not been formally done yet, but General Abrahamson has also asked if I would report directly to him. Chris and I are very comfortable with that and think that that could work to everybody's mutual advantage.

(Viewgraph A-2.) Let's see. Here's where we are—development status. We used to show you a chart that went back to 1970. I guess now thats it's 1982 we'll begin not to do that anymore.

You know how we did on STS 1 and 2. STS 3 preparations are moving along and I'll say more about that in a minute. Most of our major ground testing is completed. There's a couple of things I want to talk to you about.

Almost all of the work and data that we're seeing out of OFT correlates pretty well with the math models and what we expected to happen. As a matter of fact it's, I would say, very gratifying to see how well the flight data correlates across the program. There are a few areas where there's some differences, but it is amazing how well the analytical and test programs have led us to understand what was going to happen and it's coming out about nominal.

STS 3—this chart is outdated. It's not February 17, it's February 16. We're going to move to the pad tomorrow, February 16. The rollout review was last Friday. Everything was fine. We have a flight readiness review for March and are on schedule for March 22 in which, by the way, we have a comfortable amount of pad.

After the time we get hypergols onboard which is about March 7 or 8, we have four open dates—four—for crew rest or anything else we want to do.

(Viewgraph A-3.) So, it's comfortable. The flight rate that we're looking at is 3 this year, 5 next year, and 10 after that, 1984 deliveries of the orbiters we've talked about. We have recently agreed to accelerate the production of the engines—this is the flight set for OV-099. This will be a flight set that we can use for 103 or for 102 when it returns to the field. We can probably use these for 102, flight set 4 for 103, and then the next set for 105.

We have one major——

Congressman FUQUA. The accident that happened that shuts down at NFTL Thursday or Friday, is not going to have any impact——

Dr. LUNNEY. No.

Congressman FLIPPO. You feel you have adequate funding to meet those delivery schedules?

Dr. LUNNEY. Yes; it's pretty tight in 1982 but we've been working hard to find a way in the program to accelerate the delivery of engines so we have enough hardware assets in the program. We're really pretty concerned about that. We figure that for a small amount of money in 1982 we can go ahead and accelerate delivery. Everybody in the system has bought that and General Abrahamson has agreed to fund it.

Dr. KRAFT. I think—you may have heard, Ronny, that we were having problems getting enough money at Marshall to do some of

that. I think that the way we've been able to rework the budget we are going to be able to deliver those engines earlier. I think Bill Lucas is a lot more pleased with that situation than he has been.

There is one thing that concerns me. I don't want to make any big issue about it, but we presently have the three engines that are going to go in OV-099, going through a full-scale, three-engine test at MPT. I personally believe that to be rather risky. I'm not sure it wouldn't be better to go ahead and put those three engines in OV-099 and wait a little bit until we get three more engines of some kind to put in a high thrust level at MPT.

The problem is budgetary. We've got to have all those people there. You've got to do something with them and then bring them back or pay them while they're there. It's my personal opinion that's a high risk thing to do with the three engines you're going to have to put in OV-099. You may have something happen that bears no relationship at all with the engines. You may have a problem with the test facility and blow up one or all three engines. That would be very bad when you want to fly all those flights with OV-099.

Congressman FLIPPO. Very good point.

Dr. LUNNEY. We intend to do the planning that allows that. Then take a look after STS 3 at what we want to do about it in terms of the rest of those flight assets for OV-099.

External tank, first lightweight delivery is in support of flight 6, which is scheduled for January 20, 1982. Filament wound case SRB is now coming into the program probably for delivery out in 1985.

We're going to use a high performance SRB motor on flight 8 in 1983 and the Kennedy second-line is prepared to handle the second orbiter.

(Viewgraph A-4.) On the first two flights we had good performance. We did have a scare from SRB overpressure on STS-1. You've heard a lot about that, and we think that's pretty well settled. On the subject of debris, we still have some work to do. This is probably the residual problem that's of concern to me.

(Viewgraph A-5.) This pad modification is what we did for the overpressure problem. These are the so-called water troughs to keep the pressure wave from the vehicle. That is, keep the pressure wave down in the hole.

(Viewgraph A-6.) This is the spray system to try to reduce the strength of the wave as it goes into the exhaust hole where it was reflecting back out.

That worked very well as you've heard.

The reduction overpressure is on the order of 20 percent of what we saw on STS-1.

(Viewgraph A-7.) As far as debris goes, we saw better performance in STS-2. We saw some damage in the body flap. This is the body flap area of the orbiter.

(Viewgraph A-8.) On STS-2 we believe the damage was caused by pad debris. The pad has a fair amount of a white rubbery substance to keep it from being eroded too much. That material flies around after launch. We saw a number of cases on flaps where it would hit the body flap or the aft fuselage area. We have some more work to do to clean that up before the next flight.

Most performance areas were nominal. Ascent performance—we're down about 2 seconds which translates into about 2,000 pounds of payload performance. We still don't really know what the problem is. We've repeated it on STS–2, so it is there. It's real and it's in the vehicle. There are a number of technical panels assigned to try to figure out what the problem is and what we can do to get that performance back. We don't have any answer today and I'm not exactly sure when we're going to get the answer, but we have a lot of work going on to try to regain that performance.

The lofting characteristics we experienced had an unmodeled set of forces, probably aerodynamically influencing the vehicle. We have seen that twice. It was compensated for about half the effect on STS–2. We will now compensate completely for that. The second stage was similar to that of STS–1.

(Viewgraph A–9.) Orbiter project status. Aaron and Chris were just out at Downey. Perhaps I could ask Aaron to stand up and talk about the orbiter status as we review each of the elements of the program. Aaron?

Mr. COHEN. On OV–099 we're in a posture that I feel we will deliver on June 26. The tile work is going well. I believe we are close to the plan for tile installation.

Congressman FUQUA. We were out there about a month ago——

Mr. COHEN. Yes, but that's predicated on finishing May 14, so we've got a little pad in that. I think overall we're doing well. Today we're doing testing. We're in our modification period where we put some additional wiring in and added instrumenttion that we couldn't get in previously. I feel OV–099 will be delivered with the OMS pod. Another OMS pod will be there in March. I feel the OV–099 will make its schedule.

(Viewgraph A–10.) That's crew module. It's a little bit further along at the moment. I feel the crew module is on schedule. The aft fuselage is close to the plan. We're down a week, maybe a little bit longer, on secondary structure, but we expect to overcome that. I think 103 in all elements is good.

(Viewgraph A–11.) The wings are doing well. The fuselage we were supposed to ship in February will be ready around the first of March. I don't see any problem with that. Overall the 103 will hold its schedule. There's a lot of work to do. A lot of tiles are coming in and we're prepared to accept the midfuselage. As Chris said, the parts are starting to come in.

The aft fuselage, which is our pacer, is getting started.

Dr. KRAFT. You probably heard we were considering slipping 104 because of the budget situation. We are very pleased that under the present 1982 and 1983 budget circumstances we will not have to do that. The reason I was concerned is we do not want to get ourselves in a position where we have to delay a lot of subcontracts. I think we were heading for another impact to the program. When you stop and then have to start back again you're going to have the same learning process that you had in getting the parts delivered for OV–103.

You can't expect to lay off experienced people and replace them with new people and continue to produce the same. It takes a lot more than tapes to run a machine. It takes the person that under-

stands where those blades are going to be when you're cutting those parts. I'm very pleased that we're not going to have to do that.

Dr. LUNNEY. As Chris just said, we just went through a heavy exercise over the last few months and are still in it for 1982 and 1983 assessing how much money we think will be available and what we have to do in the program.

We went into that exercise wanting to maintain every bit of program content that has been outlined. We came out of it, feeling like we can maintain every bit of content that we have in that program; 1982 is our usual story. We're going to have a tough budget control problem to figure out how to make it. At this point, 1983 looks a little more comfortable than it usually does at this stage of the program. Frankly, we were worried about the problem of going back and picking up work after it has been stopped. Other than that, we feel like we have a stable content. We have been through the whole thing and have been able to show that the content can be held, and we really feel pretty good about it.

Congressman FLIPPO. Do you have any observations on 105? I mean the fact that there's no funds in the 1983 budget for early commitment and the review that you've made out? Do you think we would be able to go forward with the 105?

Mr. COHEN. We've been working a number of exercises with General Abrahamson to see what we can do to get 105 in the time period August 1986 or July 1987. We need to get started right now to do it. We worked that in terms of 1982—what we need in 1982 to really get started, and there have been numbers estimated. We've worked the numbers very hard and sent a letter up to General Abrahamson very recently, about $14 million in 1982 to get started.

Congressman FUQUA. Well, what about 1983?

Mr. COHEN. It depends on when you need it. If you're talking about the July 1987 time period, we're saying it's like a hundred million in 1983. If you want an August 1986 delivery, you need $250 million, according to parametric studies.

Congressman FUQUA. But there's no money in 1983 for 105, is there?

That's right, sir.

Congressman FUQUA. It's my understanding that they were going to take some money out of the total Shuttle program to do long leadtime.

Dr. KRAFT. That was the $14 million that Aaron referred to.

Mr. COHEN. We need the $14 million in 1982 to get started.

Congressman FUQUA. I thought that was going to be done in 1983.

Congressman FLIPPO. There's certainly a lot of unanswered questions.

Mr. COHEN. Yes. We told them what we need, to make those dates. We need about $14 million this year and it's primarily for the aft fuselage.

Congressman FUQUA. That's about my understanding for several years that we had a free ride up until about halfway 1983 and that it was either put up or shut up on the 105, and the ride was over.

Congressman FLIPPO. That phrase sounds familiar, Mr. Chairman.

Dr. KRAFT. I think General Abrahamson is trying to get the program in a position where he can say more specifically what those dollar requirements are both to the OMB and the Congress.

Congressman FUQUA. Well, he's also looking at maybe a batch buy with 104 and 105.

Dr. KRAFT. I think we've given up on including 104 in a batch buy with 105.

Congressman FUQUA. Really?

Dr. KRAFT. Yes. In terms of our contractual look at it, it didn't make a whole lot of good sense to negotiate 104 and 105 together. There are pros and cons for that. I don't propose to discuss that here. We told the General what we need in 1982 and 1983 to get the program into some reasonable balance to go to 105.

Dr. LUNNEY. I think we have some more pictures to show you on the status of the vehicle.

Mr. COHEN. (Viewgraph A-12.) That's the crew module on OV-099. (Viewgraph A-13.) That is the nose cap with the forward RCS mated on the vehicle; you see the tiles installed with all the work stands and the wings have all the leading edges installed. All the leading carbon material is on. The trailing edge is being worked very hard. The payload doors are in the process of being prepared for the final rigging. We plan to power up soon. (Viewgraph A-14.) This is the 103 aft fuselage with the thrust structure installed. (Viewgraph A-15.) Here you see the lower part and the top part of the fuselage being mated.

(Viewgraph A-16.) This is the crew module of 103 with this initial systems installation. (Viewgraph A-17.) This is the RCS module systems installation.

Dr. LUNNEY. The other observation I would make is that we've been holding the June 1982 delivery of OV-099 for how long now?

Dr. KRAFT. A year and a half?

Dr. LUNNEY. Yes. Perhaps longer than that. But of that order. We still feel that we're going to make that, give or take a little bit. I don't think there's any question on that. As a matter of fact, we've been holding that relatively stable for about the same period of time, a year and a half, 2 years. Remember September 30, 1982, of the first operation flight? We're going to miss that by a little bit, but not enough to be concerned about. We going to miss that by maybe a month. We should launch that flight in October or the first part of November. So for both of those kinds of major milestones, both production and in terms of starting the operational flight rate, the schedules have been holding.

(Viewgraph A-18.) The engine production is in the handout. (Viewgraph A-19.) This is the thrust profile for the three engines that we have been talking about. (Viewgraph A-20.) The engines for the second orbiter are scheduled for a test at NSTL in this configuration. This is the way we've done all the other main propulsion tests. The question remains as to whether we'll use the flight OV-099 engines as Chris said.

(Viewgraph A-21.) This is what the new tank is going to look like. I'm sure you've seen it, but I've had a lot of people ask me about it. We saved about 600 pounds of weight by not putting white paint on it.

Congressman FUQUA. I've heard someone say it's called auburn gold? [Laughter.]

Dr. KRAFT. I suspect we'll have a lot less debris in this next flight because I think that's what a lot of that stuff was.

Congressman FUQUA. Maybe you could whitewash it.

(Viewgraph A-22.) Don, you asked about the Michoud plant capability, that was reviewed at MSFC and Michoud. Were you satisfied with that discussion?

Well, I'm not sure that I still understand all the money they're going to need, but they went into that in detail and he said you had talked to them.

Dr. KRAFT. We've talked about this in our meeting on the budget. The problem that Dr. Lunney and I have is that we realize that by 1984 or 1985 there's going to be a strong demand for flying shuttles. We're going to be stuck with the fact that we couldn't provide more rockets and tanks to fly those machines. We're going to have orbiters, but we just won't have the tanks and rockets to go with them. That's going to be a shame. We've been trying to figure out how can we carve something out of the budget to allow us to increase that rate a little bit.

Congressman FUQUA. Well, that's the thing that concerns me that when we go into this major—I think it's major—redesign of the assembly line that we don't have to go back again and do it when we're in midproduction if we're going to 24 and things are moving pretty fast through that place, then we decide that we need to go to 36 or 48 or whatever, then we have to shut the line down in order to do it and all the expense involved. And what we're doing—let's do it right now and not have to worry about that later on or have that reserve capacity there.

Dr. KRAFT. That's a problem that all of us have been faced with in the management of this program in the last few years. We could see where some up-front money would help us in these kinds of things but we just don't have it to put on the program. That's not an excuse, it's just the fact of life that we're trying to face up to.

Dr. LUNNEY. I would expect, if we really find ourselves in that position some day, we're going to have to seriously entertain opening a new one rather than trying to close it down or slow it down in some way to make a major modification. If we had to make one to go above the 24, I think we'd open another one.

Congressman FUQUA. Well, they talked about maybe one on the west coast for the Vandenburg launches.

Dr. LUNNEY. Well, you know what that flight rate looks like.

Congressman FUQUA. Well, like I said, they ruled that out.

Dr. LUNNEY. Yes. We haven't done anything about if for the time being. There's a long leadtime to get into something like that. There are a number of people beginning to stir around on the subject. The General Dynamics people that build the big pressure vessels for the LNG tankers have been down talking to people about their product and how they know how to do that, et cetera, so who knows. On the subject of (Viewgraph A-23) SRB's you know of stacking the rockets and tanks on the mobile launch platforms is probably going to become the pacer in our clock. (Viewgraph A-24.) I don't mean necessarily the stacking, but getting these SRB's ready to fly and getting them to the platform. (Viewgraph A-25.)

This whole job of recovering them and taking them apart and back to Thiokol and back to the cape will be a demanding one. I think that's going to end up being the clock that determines how fast we're going to be able to run this program in the mid-1980's. (Viewgraph A-26.) Overpressure. We think we've solved the problem for KSC. (Viewgraph A-27.) We're going to stick with the configuration that we have. We're going to put some more instrumentation on the launch platform to see whether we can reduce the provisions we've made and make them a little simple. (Viewgraph A-28.) We are going to do some firings for the Vandenburg configuration. We had an unexpected occurrence other there in the first test. That configuration has a lot of water sprays. The water really came back out of the firing holes, higher than we expected. We didn't expect it to come out of the hole at all.

We have some work to do. We're down for about a month while people try to understand that.

Congressman FUQUA. Are they going to put baffles in there?

Dr. LUNNEY. Some of the water is directed up, or at least horizontal, in the SSME and SRB holes. So I think it's just a matter of figuring out what went wrong and redirecting the water spray or locating baffles that would keep the water from coming back up out of the hole. (Viewgraph A-29.) These are the dates for the major facilities at Kennedy. (Viewgraph A-30.) You know what Kennedy looks like. (Viewgraph A-31.) On the right is a picture of Vandenburg as it's going together. Arnie Aldrich was out there on a visit a few weeks ago and he's very impressed with the facilities and how the job is going.

We're in the process of a study with the Air Force to see how much we can support their operations from KSC to defer expenditures of major investments in the equipment that they would have to put into the various facilities. Like, for example, the facility to process the SRB to build up the aft skirt and put all the equipment in and put the TPS on it. It looks like for our first flight and some subsequent flights we would do that from Kennedy and ship them a fully configured SRB aft skirt.

That's yet to be concluded but probably will be some time soon.

Congressman FLIPPO. I heard something about wind problems or something out there on construction. You must have been out there—do you know anything about that?

Mr. ALDRICH. We didn't check the wind problems on construction. We've been discussing the weather.

Dr. LUNNEY. You mean perhaps putting the orbiter up and joining it to the tank, yes. As a matter of fact, they're building a shelter around it as a wind screen to keep the wind from blowing the orbiter around while mating it to the tank.

Dr. KRAFT. Ice problems are still a technical issue, too.

Mr. ALDRICH. I was going to get into that—the ice and a discussion as to what the weather will be and how the program will deal with it.

Dr. LUNNEY. And how much ice will be in the tank. (Viewgraph A-32.) Operations and training. (Viewgraph A-33.) This is the mockup area over in building 9-A with the two mockups that we have. This being the mockup of the cargo bay. (Viewgraph A-34.)

This is a test in the water facility of the EVA process. We're going to have to begin to consider those as we move into——

Congressman FUQUA. The water tank is working well?

Dr. LUNNEY. George, you want to comment on the water tank? As to how well it's working?

Mr. ABBEY. I think it's working very well. During the course of a normal week we use it probably two or three times a week. A lot of the activity right now is related to contingency training on the doors, but we'll be moving into some more work later on. (Viewgraph A-35.)

Dr. LUNNEY. We looked ahead to the early operational flights and Jerry Bostick will talk about this some more. We've got a pretty fair number of flights spelled out in some specific terms through 1983. The solar maximum retrieval and repair schedule is still under discussion.

This 1982 sequence of flights is fairly tight. On the other hand, in the course of the last half of last year, we got a very good understanding of what the work was going to be in 1982 and pinned it down.

We are approaching the same point in another 3 months or so where we will have a good understanding amongst all the members of the team of what has to be done during 1983 in terms of the five or six flights that we're going to be flying. We feel pretty comfortable that when that gets done, we're going to be comfortable about that schedule.

We have already begun to see improvements at the cape that people intuitively knew were going to happen but could not schedule.

Aaron worked with the cape on some GSE and some special training for the mating of the tank and the orbiter. Time on the STS-2 was 180 hours or something like that?

Mr. COHEN. On STS-2, to mate the orbiter and the ET took 181 hours. They did a study of it and modified some ground support equipment and for STS-3 it was 60 hours. A little investment in some equipment improved the timing greatly.

Dr. LUNNEY. An observation, that is beginning to work in this particular case and in a number of areas across the program. I think even some of the operations people at the cape who were at first kind of conservative are becoming more bullish about what they're going to be able to do on the schedule through the rest of 1982. They're really getting pretty comfortable, I think, with the work that they have to do and their ability to handle it and the times that have been allocated. They're really getting pretty comfortable with it.

So as we move into the program we find it useful to remind ourselves that we're in a very long-term enterprise. (Viewgraph A-36.) As a matter of fact, the long-term nature of it sometimes gets obscured with more near-term budget discussions. Even what we're doing in product. We refer to four orbiters as a fleet, but in reality, rather than a fleet, it's something more like two pair when you think of operating those systems for 25 years or more, which has been the life cycle of the ELV's that we've flown. We expect those vehicles to be flying long after those of us in this room are working on it. Four is a small number.

We understand what is being asked of us. As we move into the point where the Shuttle becomes a primary launch vehicle of the country, we fully understand the responsibility it brings. We fully understand what the nature of the job is. To bring this enterprise into an operational phase. We don't have all the answers, but we approach it with the same degree of confidence and enthusiasm that we've done all the other jobs that we have been assigned. We're looking forward to getting on with it. We want to establish schedules and maintain them. That's a high priority we hold for operations.

So far we've done that. We think we can meet the schedule that we have laid out through 1985. We want to be sure to take care of the customers and, as Chris said, find a way to get some more flight rate margin built into this thing for the future. We don't know what the country is going to want to do. We have been surprised before. We're liable to find reasons for doing things we don't fully understand today because of changes in the international climate or environment. Something is liable to happen. We want to be able to get enough flight rate margin so that we have it available if the country needs it.

We think we're going to be able to support a lot of new activites. These are the things that are just beginning to come into the program in the area of DOD and national security. It is what they will be able to do when they fully utilize the Shuttle and couple that with a space base operation. What is possible in terms of capability to geosynchronous and other altitudes. It's just beginning to dawn on people, I think, what that could lead to.

In the commercial area, you are familiar with the Johnson & Johnson, McDonnell-Douglas continous flow experiment. We're going to fly that in the STS–4 this summer. We're looking forward to that flight test as much, I think, as those two companies are in terms of what it will portend for the future. We could easily find ourselves with a community of users who are just as big and perhaps a lot bigger than the communications satellite industry.

We should be able to do the kind of things that NASA has wanted to do. We believe the way in which we'll be doing interplanetary or high altitude observations in the future will be to build things up on orbit so we won't be dealing with the limitation of one launch. We believe in a lot of ways the STS is a contribution to the operational capability and a contribution to the spirit of our people. In terms of being proud of what the U.S. Government and the country are doing in this area.

In the program, there is this sense that we're just about on the threshold to see both our flight rate and flight schedules being maintained. The hardware works, we've reused the orbiter one time, and every indication is that it will work very well for us. We don't see any areas to be concerned about with the orbiter. The downstream schedules look tight but workable—more comfortable than the predictions we've been able to make in the past.

The MSFC team has probably told you about the maturity of their projects.

For example they're well into tank production. There is a pretty good assessment for tank production. They've got a pretty good idea of what they have to do with the facility down there.

The SRB is in the same kind of category, although I think that is going to be the area that's going to take the greatest attention in terms of turnaround and planning for the mid-1980's. The engines are in good shape—we've produced an awful lot of engines. They know how to produce them.

We've just finished the first of four certification cycles over at NSTL on the 109-percent engine. It went very well. People are comfortable with it. We still have some work to do on service life. We think we have a design for the 109-percent engine that works and we will be bringing that into the field. We hope to be able to change out the engines on the 102. The accelerated engine plan I described, will allow the changeout and we will only have to fly five times rather than the eight or nine.

Congressman FUQUA. Glynn, as a result of the STS–2 flight has there been any significant change—I'm not talking about engines that you flew, but any damage or any wear and tear——

Dr. LUNNEY. We did some planned inspections and repairs on the high pressure pumps, but there's nothing of concern there. Most of the 109-percent knowledge has come out of the nonflight area. That is, out of the test program run at NSTL.

That program is coming along fairly well. We did run the engines att 111 percent, by the way, and there is a little vibration on the LOX side but workable. We flew the certification engine all 111 percent for three hundred and some seconds and there was a little more vibration on the oxidizer side. Not enough to shut it or the test down. As an overstress test we seem to have some margine built into that machine. We just haven't seen anything that indicates a roadblock to 109 percent. Everything that we've seen indicates that we're well on the way to doing that.

We will start the second and third certification cycle of the four, within the month. We have some work to do when we put the new engine on the pad. We'll do some feturbishment work on the one that has just been through this cycle. We'll probably be back in test by March with both engines.

The last certification cycle ran about 3 months at NSTL. If we were to do that well again we should have three certification cycles by late spring or early summer with one to go. That really looks encouraging. Most of the review committees, I should say all of the review committees, seem to be bullish also.

Congressman FLIPPO. Glynn, we've talked about orbiters and shuttle main engines and the SRB's and the external tanks and everything. What about the crew area? Are there any unresolved safety issues? We've talked about long-term lead things. Anything in regard to the crew training, facilities or——

Dr. LUNNEY. We've done one thing that we think will be very useful with respect to the crew. We've been concerned about the changeover between 102 to figure O–99 in the field because the cockplit panels are different. About half the panels are slightly different. We are concerned that starting with flight 5 and beyond, there's going to be a fair amount of work on the aft flight deck; payload oriented work. We had planned to have only one aft flight deck mockup in the simulators. One aft flight deck capability in the fixed base simulator. As a result of the compression of activities between flight 5 and 6, having to reconfigure the simulator be-

cause OV-099 is different from 102 we're looking at how we are going to get these facilities reconfigured. We concluded that we should augment the motion base simulator with the aft flight deck capability so that we would have two aft flight deck capabilities, two payload areas to train on in the simulator complex in building 5. We did that by converting the set of equipment that we were buying for building 35, which is used mostly to develop and debug the software loads for the operational training in building 5.

I might ask George to comment on that in terms of the readiness to fly Flights 3, 4, and 5, this year.

Mr. ABBEY. I don't think we have any concern about the upcoming flights. There is one, as we get into flight 5. We're up to a crew size of four. We're finding that to be of great assistance in handling the activity on orbit as well as the training. Because we only have to train two people and that is a very complex job.

Congressman FUQUA. How about downstream, George. Now, you know, there's a little gap between flights and we've had flight rate hazard increase but when we were in Huntsville when they were working on the simulators for the space lab and so forth, and that's 18 months away and, you know, time is really not all that critical right now, but when you start going, when, in 1984 you have 10 flights, and then the rate starts getting up to that 24, are you going to have enough facilities to train everybody, particularly what about your mission specialists? Will they probably be getting into each other's way?

Mr. ABBEY. We try to size our facilities looking downstream at that kind of problem.

With the addition of the aft station, it is going to give us the capability of two bases. We could use them interchangeably and they could be a big help.

Congressman FUQUA. Would that be enough?

Mr. ABBEY. Right now we think that would be sufficient with the other facilities that we've got. There is a problem if you don't bring 102 up to the OV-099 configuration. That means one of our simulators has to stay in a different configuration. That would be a problem. I think it's very important to get 102 back to the OV-099 configuration. If we can do that and keep a standing configuration, then I think we're going to be alright.

Congressman FLIPPO. What about further training aspects, George? How old were your T-38's?

Mr. ABBEY. Well, the T-38's are quite a bit older now. The problems we have run into, the Air Force is having the same difficult problem, is primarily with the wing. We've gone through a program of trying to refurbish the wings on the airplanes. This has caused longer downtime. We're going to find more structural problems as time progresses. I think that right now and in the next few years, recognizing that we've got those kind of problems, we could probably get by with 30 days.

Dr. LUNNEY. We have recommended adding a third Shuttle Training Aircraft [STA] to the one that simulates the orbiter, in the 1983 budget. George's experience with the present two is that we're putting that vehicle through a harsh flight regime in running those engines in reverse thrust. There's a lot of vibration. We're starting to see cracks in the tail section.

Mr. ABBEY. That's the one area that we're probably going to be scarce in because they're not making the Gulfstream 2 any longer. If we're going to get another STA we've got to acquire a low time airplane that's already used. Then we have to modify and reconfigure it to the two that we have. If we wait until the 1985 time period, with the flight hours we're projecting, we really need three STA's to get by.

Congressman FLIPPO. Finally, have you seen change of the whole crew in regards to the STS–1 and the STS–2? Is there anything there that you haven't seen before?

Dr. LUNNEY. On crew performance?

Congressman FLIPPO. Yes. Crew performance.

Mr. ABBEY. I think on STS–2 we probably need some changes in the flight plan. Recognizing that we lay out a flight plan under normal situations that is pretty full. If you start having problems that the crew has to deal with, it becomes very crowded time wise. Looking at the time line for 3, I think, we have a flight plan that's really a little more relaxed with a little more time to accommodate problems that might come up

We try to take these matters into consideration. If I say four crew members it's because it's beginning to be a very crowded schdule with a crew of just two.

Dr. KRAFT. I think the crew selection through STS–8 or –9 will be done in the next few months. We're going to be forced into that because of the training situation.

Dr. LUNNEY. Another thing about crew selection is that we are now beginning to entertain when people refly. I don't think Mr. Abbey has reached any conclusions about that yet. It's a great comfort to think not only of the flight, but the training load. Getting ready for the flight. We're going to start recyling some of the people who have flown. As we do more of that, it is going to be a great help I think that's going to work for us better than we thought. Having even one person out of a crew of four who has flown before is going to be a big step up.

Congressman FUQUA. I think we left off with that.

Dr. KRAFT. I'd like to respond to your question in a more direct way. I think what we have today are crewmen who have been trained upward of 800 to 1,000 hours in the simulators alone. Crewmen who have grown up with the design and all the verbal and technical discussion that's gone on in the preparation for these flights. I think that is part of the training.

Two years from now, the men that are going to fly are going to have 300 hours of training at the most.

I think the ability of those men to handle situations, compared to the ones that flew the first two flights, is going to be decreased. I don't think that's dangerous. I do think that it requires a proper consideration for what is done in flight and on the ground.

You can not expect men who have only 300 hours of flight training to be able to totally reconfigure this machine if they run into malfunctioning or failing hardware, which they are going to do. I think It's going to take a proper balance between the team on the ground and the team in flight to accomplish that.

That isn't to say that you need to have all those people on the ground that we've had in the past. I don't think you do. I do think

it's going to take a combination of people in order to continue the safety that we want. I don't think we can automate it. I don't think we can afford to do it on board the vehicle. You may be able to automate some of it on the ground. We have started doing a lot of that already. I think there's a lot of paydirt in that. When you have four of everything on board the vehicle, the failure rate is going to be four times as high. You can expect to see failures of hardware. You are going to have to reconfigure this machine in flight. That is going to take some doing. You don't want to do that haphazardly or with men who are not trained to do it. I don't think you can get two crewmen on board the vehicle that competent that they do not need to talk to the people on the ground. I think it's going to be a real challenge to decide what should be done on the ground and what needs to be done in flight.

Congressman FLIPPO. Are there mission control questions for the 1983 budget?

Dr. LUNNEY. Well, we have planned to move the operation to the third floor. It's now on the second floor. We're going to move the main control area to the third floor, reconfigure the second floor so that we can have two main flight control rooms there. One of them is going to be a lot smaller than the one that we know today. That is all laid out and in the plan. The area of more concern to us is what it is going to take to reconfigure the control center and get ready for each flight.

Late in 1983 we have the first control mode flight in DOD. We've made a lot of security modifications to the building. You can see by walking into the building that we've reconfigured the lobby and the entrance to it. We've also made electronic modifications to the building.

The other thing is the parking. We have a Spacelab flight in the same time frame, back to back, with the first DOD control mode flight. That's going to be a problem. How do we shuffle people in and out of the facility, let them do their job but not get into conflict with the arrangements we've had to provide the DOD. We haven't fully worked that through yet. There's bound to be some squeezing on the amount of time that we have in training and the control center. The point is how optimized and how well trained can we make the people who represent the Spacelab and payload component. They may end up not getting all the time that they would like to have. Other than that the plan is in place for the control center. It fits within the budget that has been allowed. Our problem is going to be reconfiguring it to get the time we need out of it. Jerry?

[Viewgraphs A through A-36 of Dr. Lunney's oral presentation follow:]

NASA-S-82-10210

LA
2-15-82

SPACE TRANSPORTATION SYSTEM

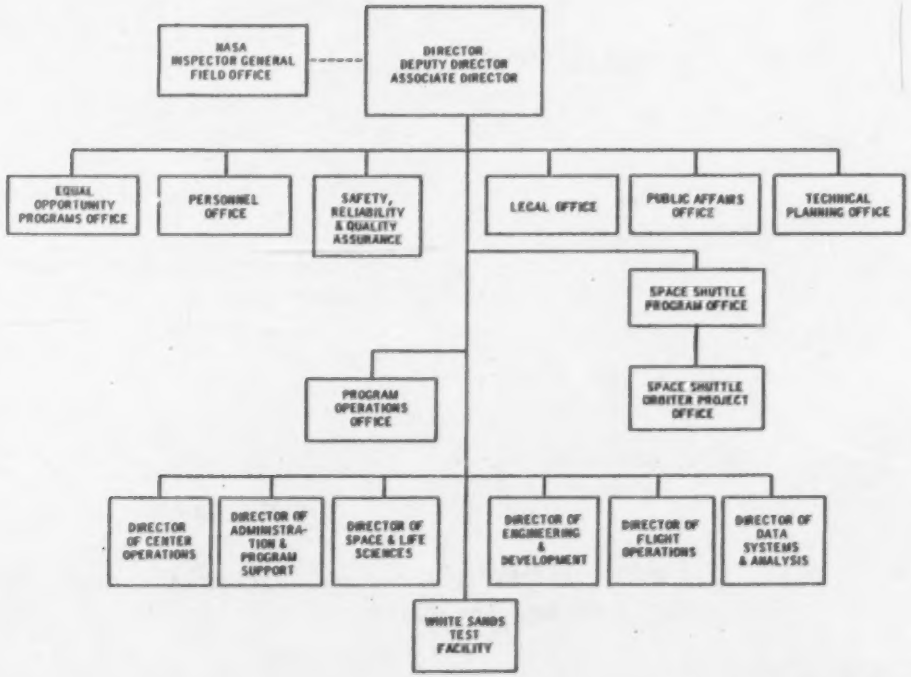
692

DR. G. S. LUNNEY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS


NASA INSPECTOR GENERAL FIELD OFFICE
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WHITE SANDS TEST FACILITY

January 11, 1982

NASA-S-82-10266

LA2 (LE)/MILTON
2/15/82

SPACE TRANSPORTATION SYSTEM
SYSTEM DEVELOPMENT STATUS

- DEVELOPMENT STATUS
  - FLIGHT AND GROUND SYSTEMS DEVELOPMENT COMPLETED
  - STS-1 AND STS-2 HIGHLY SUCCESSFUL
  - FLIGHT HARDWARE DELIVERY FOR STS-3 COMPLETED
  - MAJOR GROUND TESTING COMPLETED (INCLUDING MAIN PROPULSION SYSTEMS TESTS)
  - ANALYTICAL DATA BASE COMPLETED MATURE AND CORRELATES WELL WITH FLIGHT DATA
    - AERODYNAMIC DATA BASE
    - STRUCTURAL MODELS, LOADS, AND HEATING DATA BASE
    - INTEGRATED GN&C
    - INTEGRATED AVIONICS
    - INTEGRATED MPS

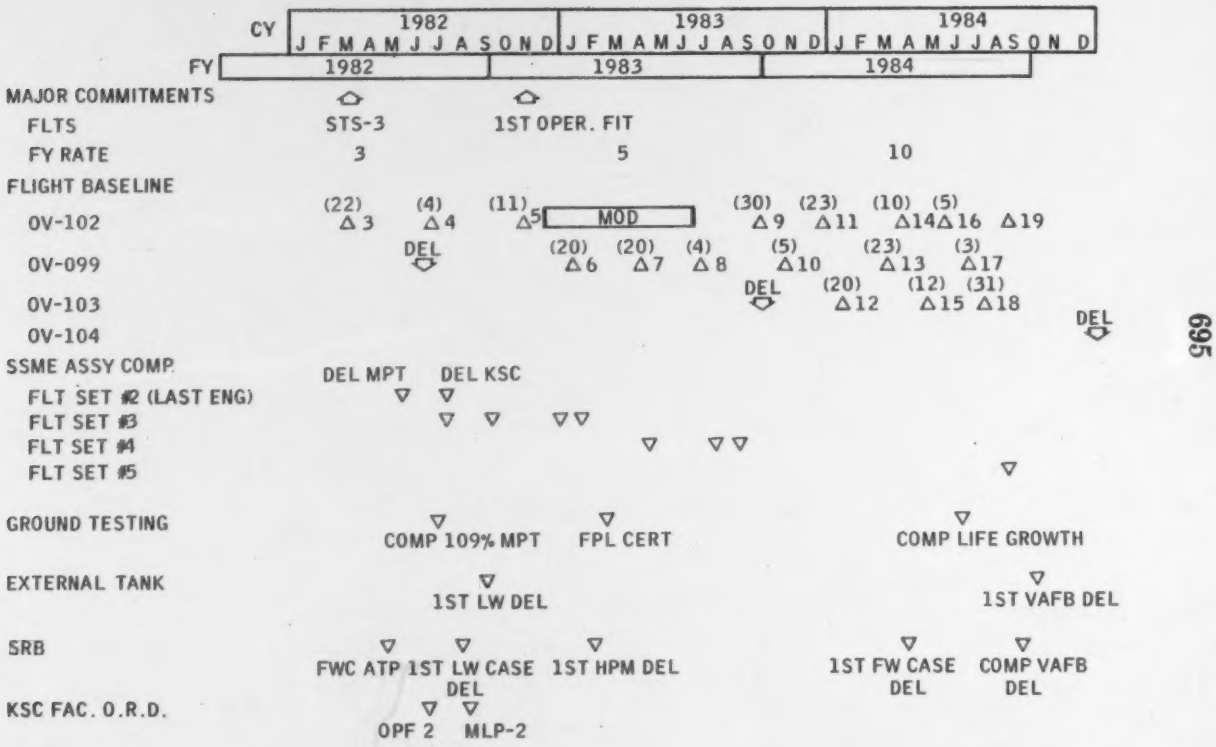
- STS-3 OUTLOOK
  - SHUTTLE VEHICLE TO BE MOVED FROM THE VAB TO THE LAUNCH PAD 2-17-82
  - VAB ROLLOUT REVIEW FEBRUARY 12, 1982
  - FLIGHT READINESS REVIEW SCHEDULED FOR MARCH 9, 1982
  - LAUNCH SCHEDULED FOR MARCH 22, 1982

NASA-S-82-10214

SPACE TRANSPORTATION SYSTEM

STS FLIGHT DEFINITION AND REQUIREMENTS PLANNING

LS VOSS
2-8-82



NASA-S-82-10238

LA2
2-15-82

SPACE TRANSPORTATION SYSTEM
SYSTEM INTEGRATION
INTEGRATED VEHICLE FLIGHT PERFORMANCE

- EXCELLENT SYSTEMS PERFORMANCE ON STS-1 AND STS-2
- CONCERNS
  - SRM OVERPRESSURE
  - DEBRIS DURING LIFTOFF AND ASCENT
  - VEHICLE LOFTING/PERFORMANCE

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S81-37393

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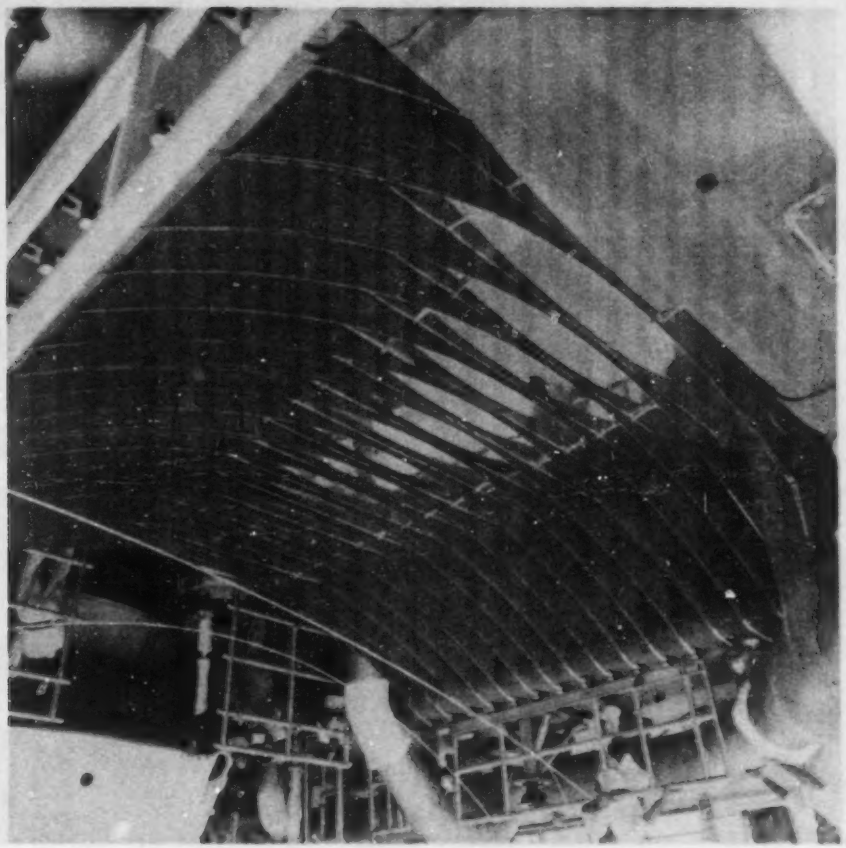
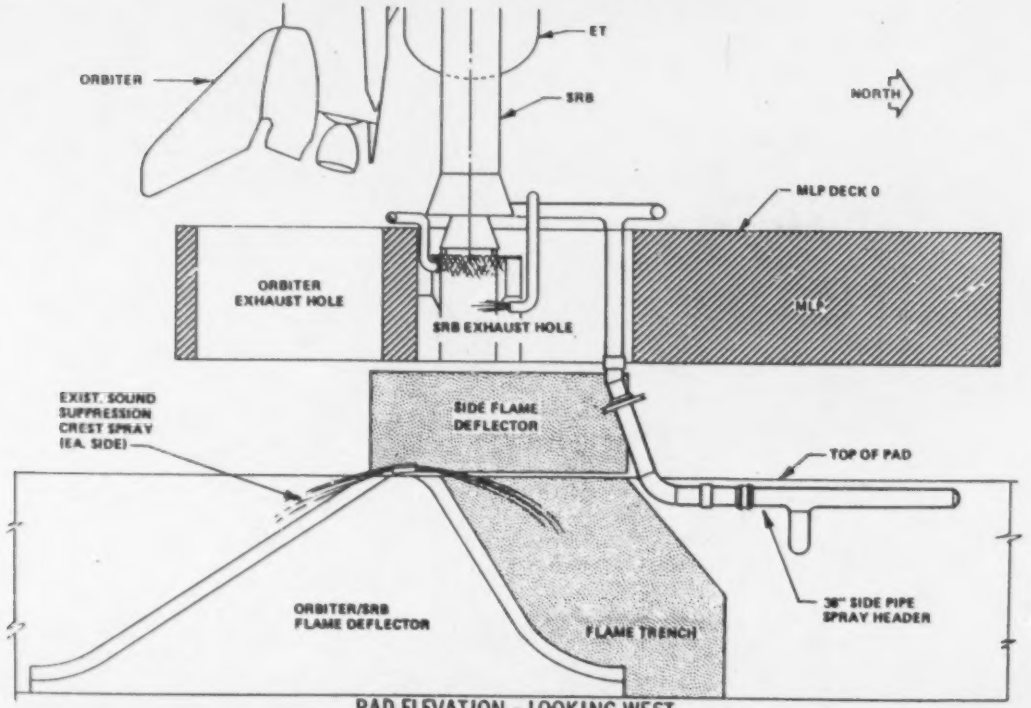


A5

NASA-S-82-10277

LA2
2-15-82

SPACE TRANSPORTATION SYSTEM
WATER SPRAY CONCEPT



PAD ELEVATION - LOOKING WEST

A-6

98-418 O—82——45

SPACE TRANSPORTATION SYSTEM
SUMMARY

- SRB IGNITION OVERPRESSURE 20-30% OF THAT MEASURED DURING STS-1
- DEBRIS DAMAGE LESS THAN STS-1
- SRB SEPARATION NOMINAL
- ET SEPARATION NOMINAL
- ET DISPOSAL WITHIN PREDICTED VALUES
- MECO NOMINAL
- ASCENT PERFORMANCE SUMMARY (STS-2)
  - 1ST STAGE
    - VEHICLE ISP LOW ~ 2 SEC
    - REPEAT OF STS-1 LOFTING CHARACTERISTICS, BUT COMPENSATED BY DEPRESSED FLIGHT PATH ANGLE
  - 2ND STAGE
    - SIMILAR TO STS-1

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S81-30542

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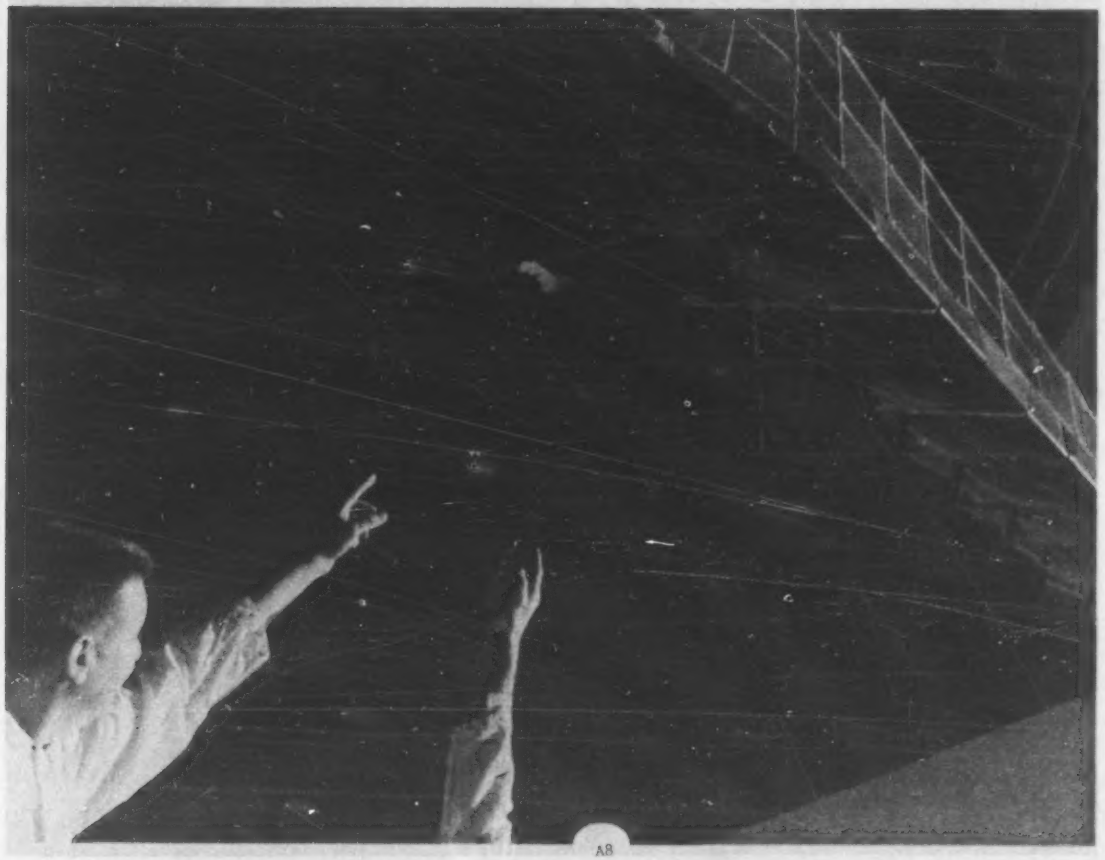

A8

700

SPACE TRANSPORTATION SYSTEM
ORBITER PROJECT
OV-099 STATUS

- ALL MAJOR SUBASSEMBLIES HAVE BEEN DELIVERED TO PALMDALE EXCEPT THE LEFT HAND OMS POD WHICH IS ON SCHEDULE FOR A MARCH 1982 DELIVERY
- 79% OF THE THERMAL PROTECTION SYSTEM TILES REQUIRED AT DELIVERY HAVE BEEN INSTALLED.
- PLANNED DOWN TIME FOR WIRING CHANGES WILL BE COMPLETED ON SCHEDULE, FEBRUARY 12, 1982.
- TESTING WILL CONTINUE STARTING FEBRUARY 15, 1982, WITH PLANNED COMPLETION OF CRITICAL PATH TESTING, MAY 21, 1982.
- MANUFACTURING ACTIVITES SCHEDULED TO BE COMPLETED MAY 28, 1982.
- SCHEDULE OF WORK THROUGH DELIVERY IS VERY CONGESTED, BUT IS STILL ATTAINABLE. EXPECTED DELIVERY, JUNE 26, 1982.

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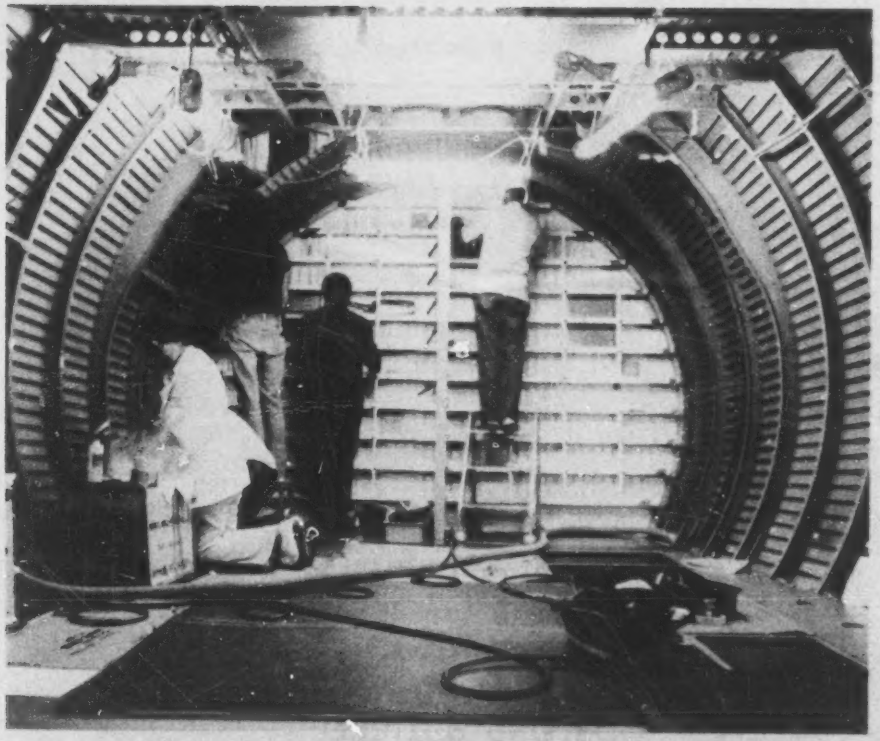

OV-103 CREW MODULE MID-DECK

A 811008 G-27

NASA-S-82-10299

SPACE TRANSPORTATION SYSTEM
ORBITER PROJECT
OV-103 STATUS

MA/GERMANY
2-15-82

- UPPER AND LOWER FORWARD FUSELAGE, AFT MODULE, AND CREW MODULE SLIGHTLY BEHIND PLAN AT DOWNEY. PRIMARY STRUCTURES MOSTLY COMPLETE, AND SECONDARY STRUCTURES BEING INSTALLED.
- MID-FUSELAGE TO BE COMPLETE AT GDA ON FEBRUARY 22, 1982, WHICH IS THREE WEEKS BEHIND SCHEDULE. THIS IS NOT EXPECTED TO AFFECT OVERALL PLAN.
- LEFT HAND WING WAS COMPLETED ON SCHEDULE AT GRUMMAN. RIGHT HAND WING IS ON SCHEDULE. BOTH WINGS TO BE SHIPPED MARCH 31, 1982, FOR AN APRIL 30, 1982, DELIVERY AT PALMDALE.
- VERTICAL STABILIZER SOMEWHAT BEHIND SCHEDULE; FAIRCHILD WORKING A 56-HOUR WEEK TO MAKE DELIVERY.
- DELIVERY SCHEDULE VERY TIGHT, BUT SHOULD BE MET.

OV-104 STATUS

- MANY PARTS HAVE BEEN DELIVERED AT ROCKWELL AND SUBS.
- AFT MODULE IN WORK AT DOWNEY.
- CREW MODULE HELD FOR SOME KEY PARTS IN MR; ONCE CLEARED, ASSEMBLY WILL BEGIN.

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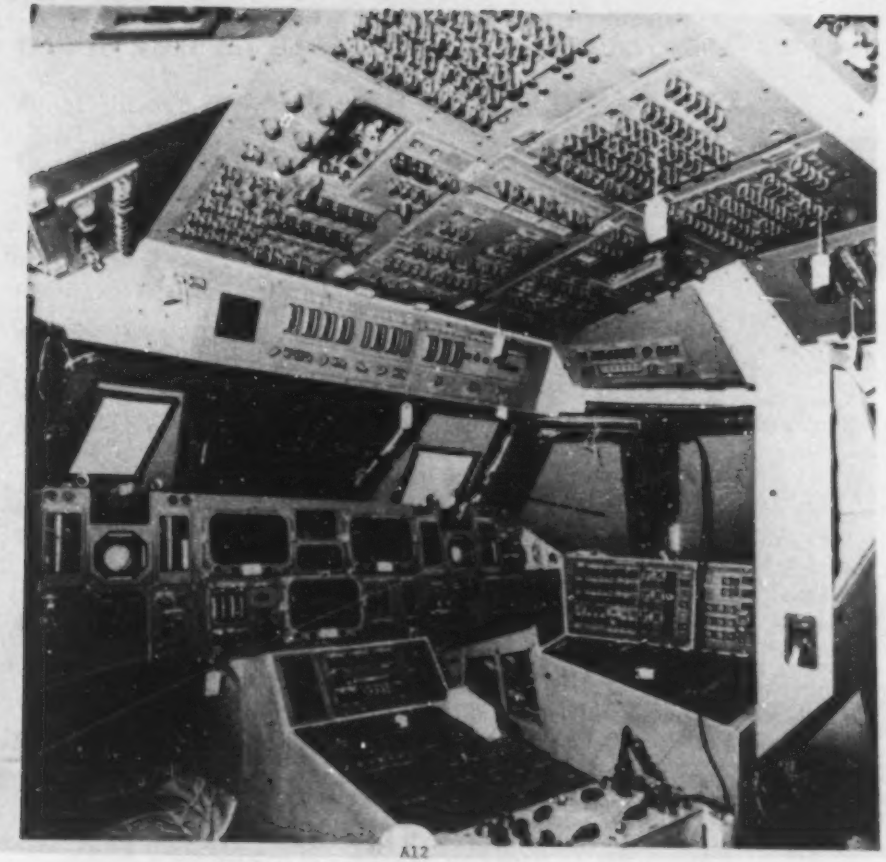

A12

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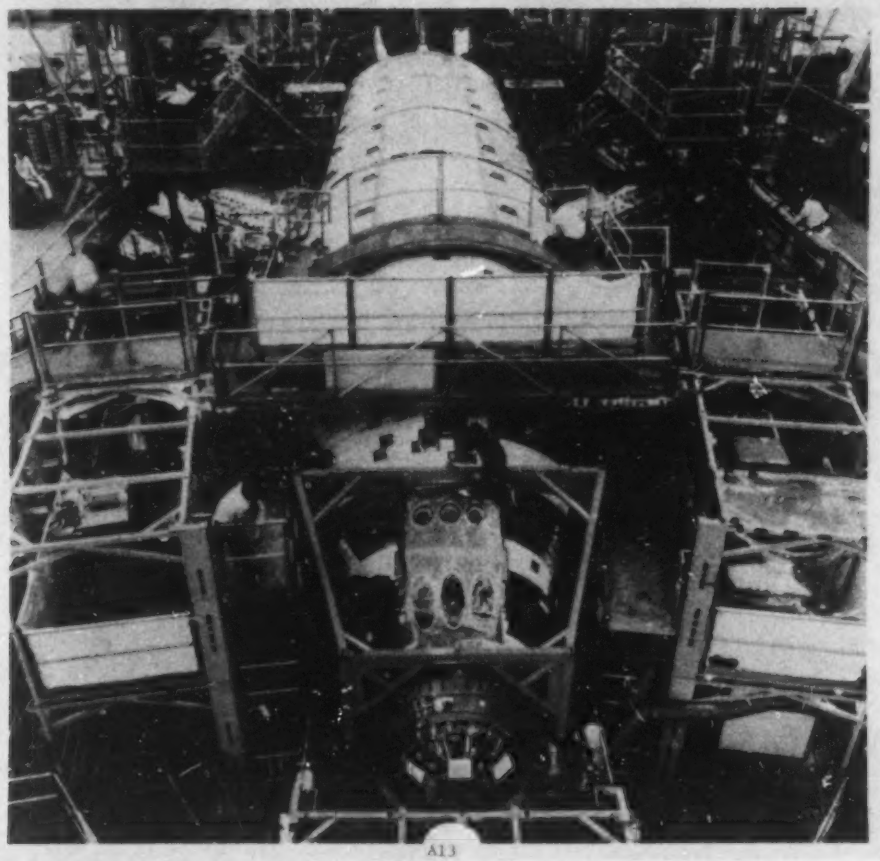

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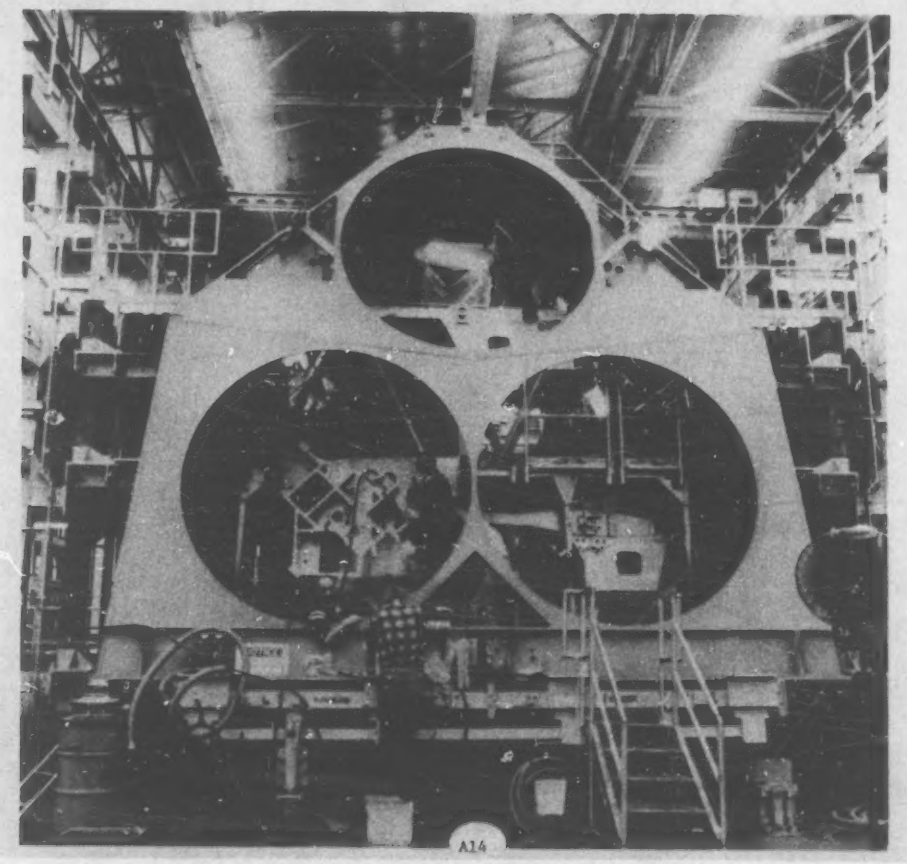

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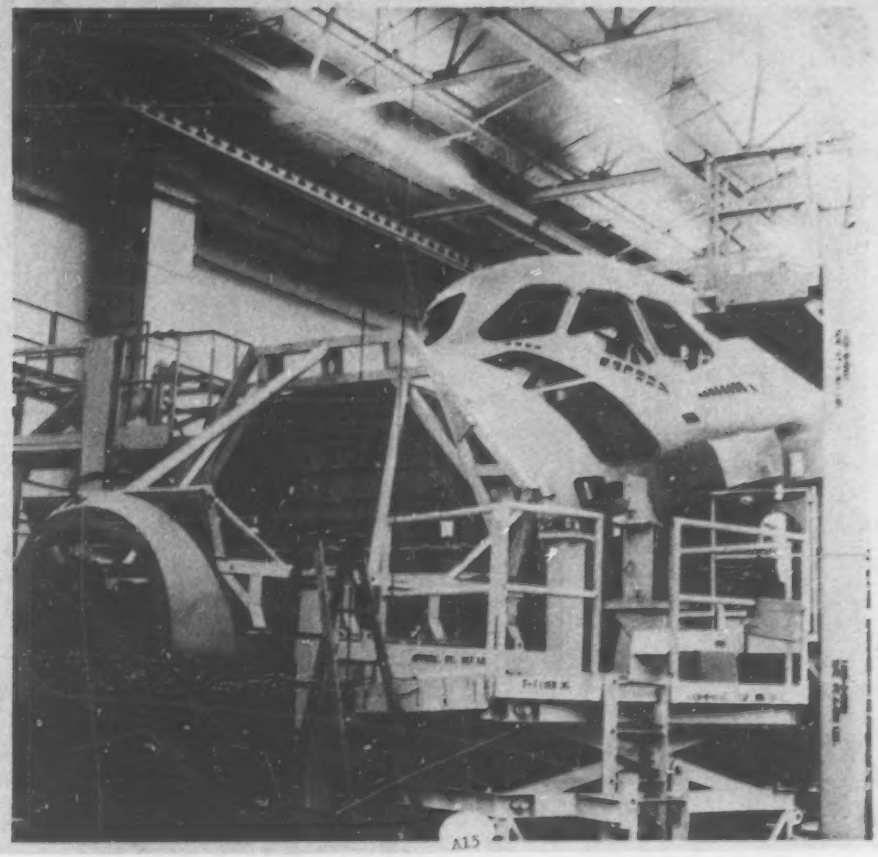

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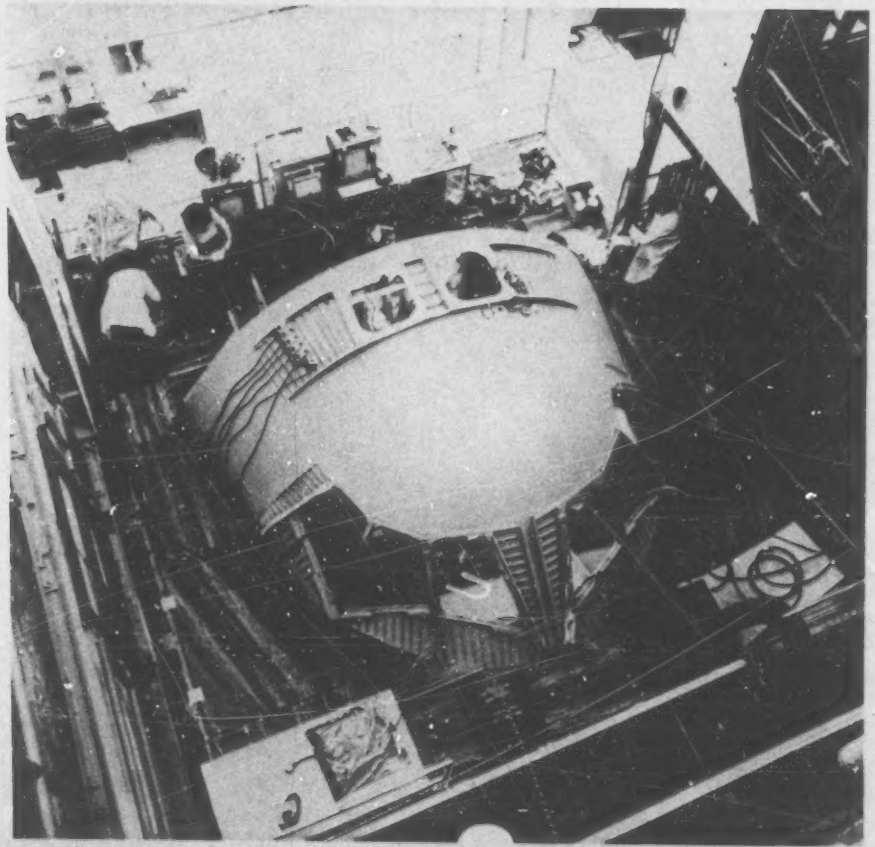

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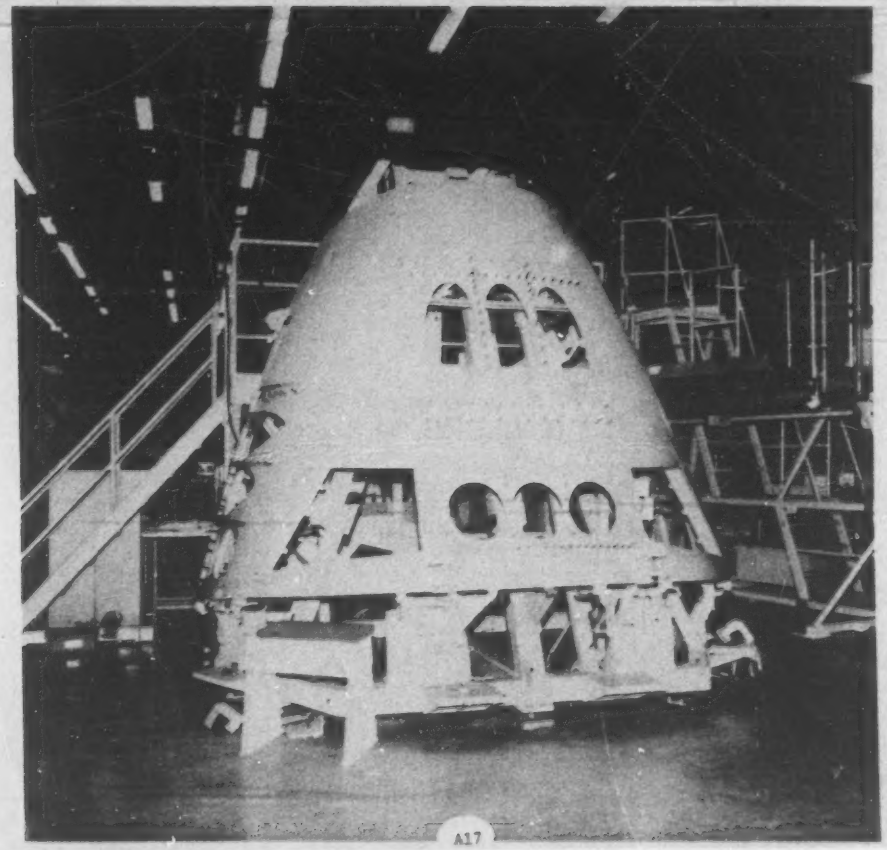


A17

709

NASA-S-82-10310

SPACE TRANSPORTATION SYSTEM

SYSTEM INTEGRATION

ENGINE DEVELOPMENT AND PRODUCTION

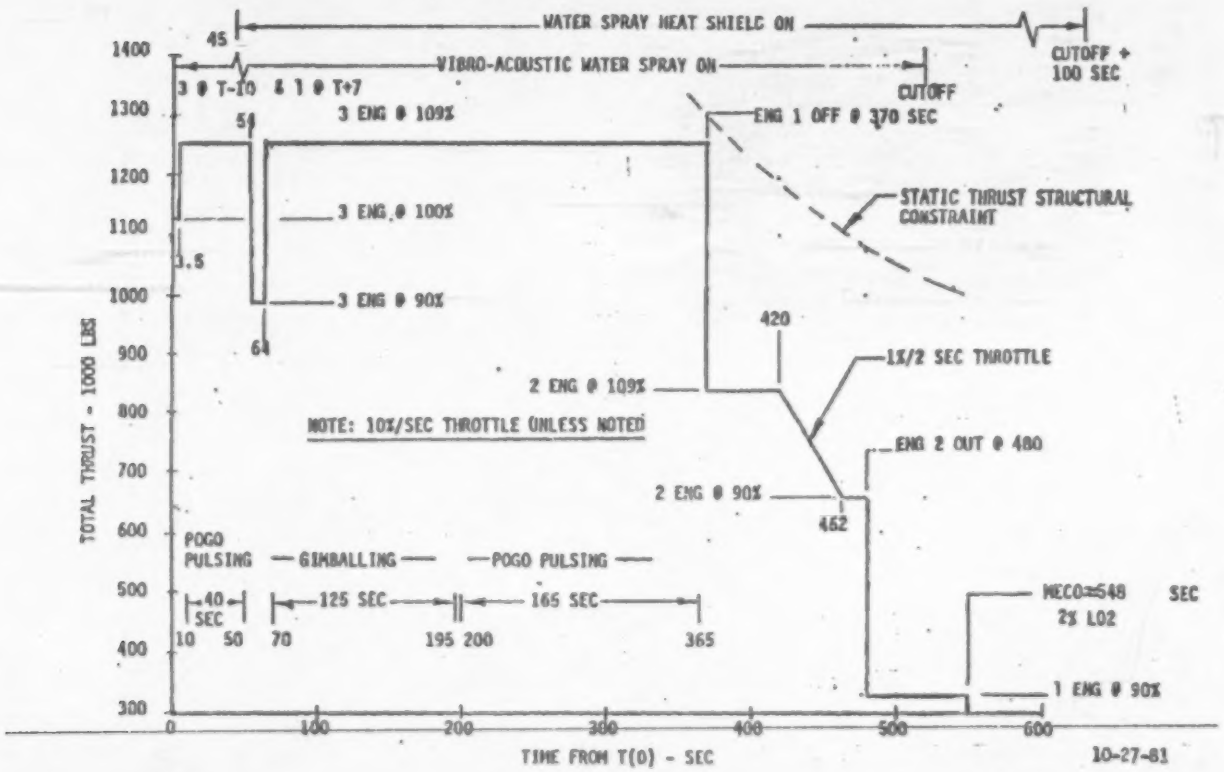
- ENGINE PRODUCTION
- SSME TEST PLAN
- MPT SF - 13 THRUST PROFILE

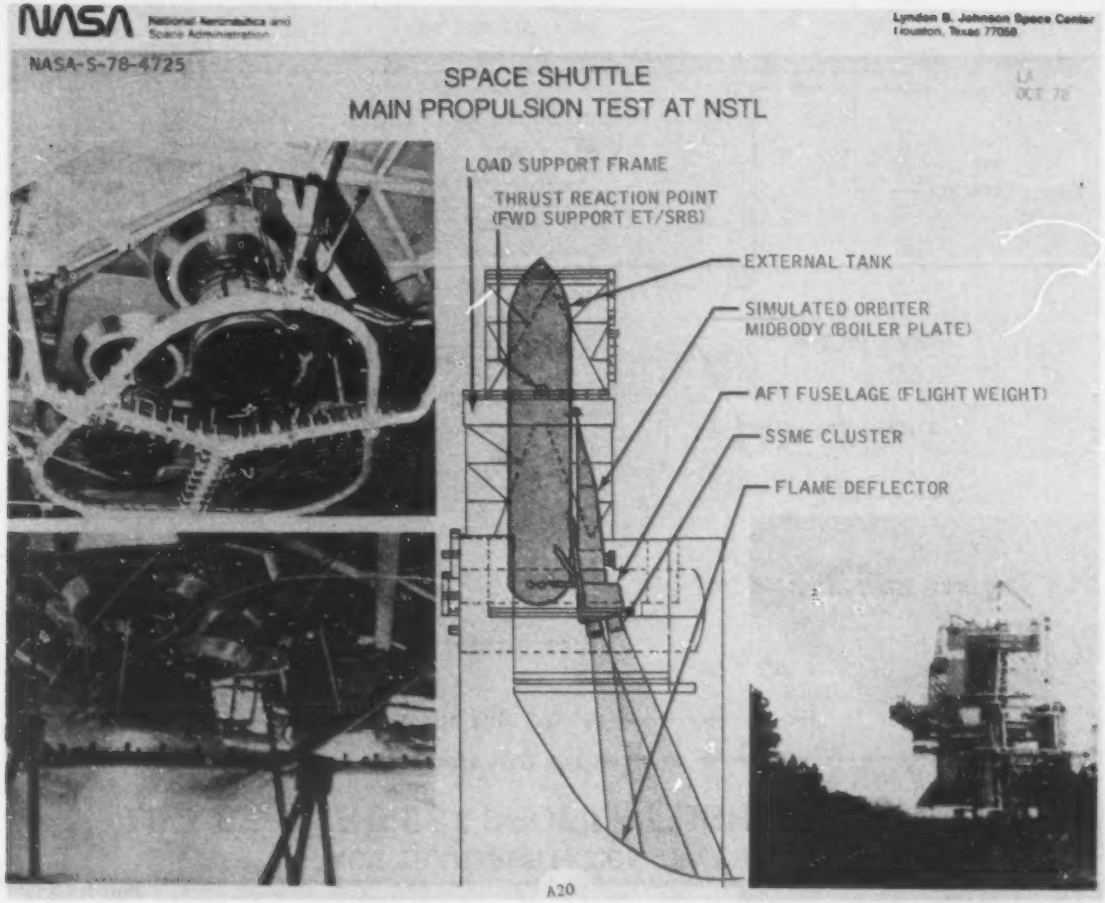
NASA-S-82-10258

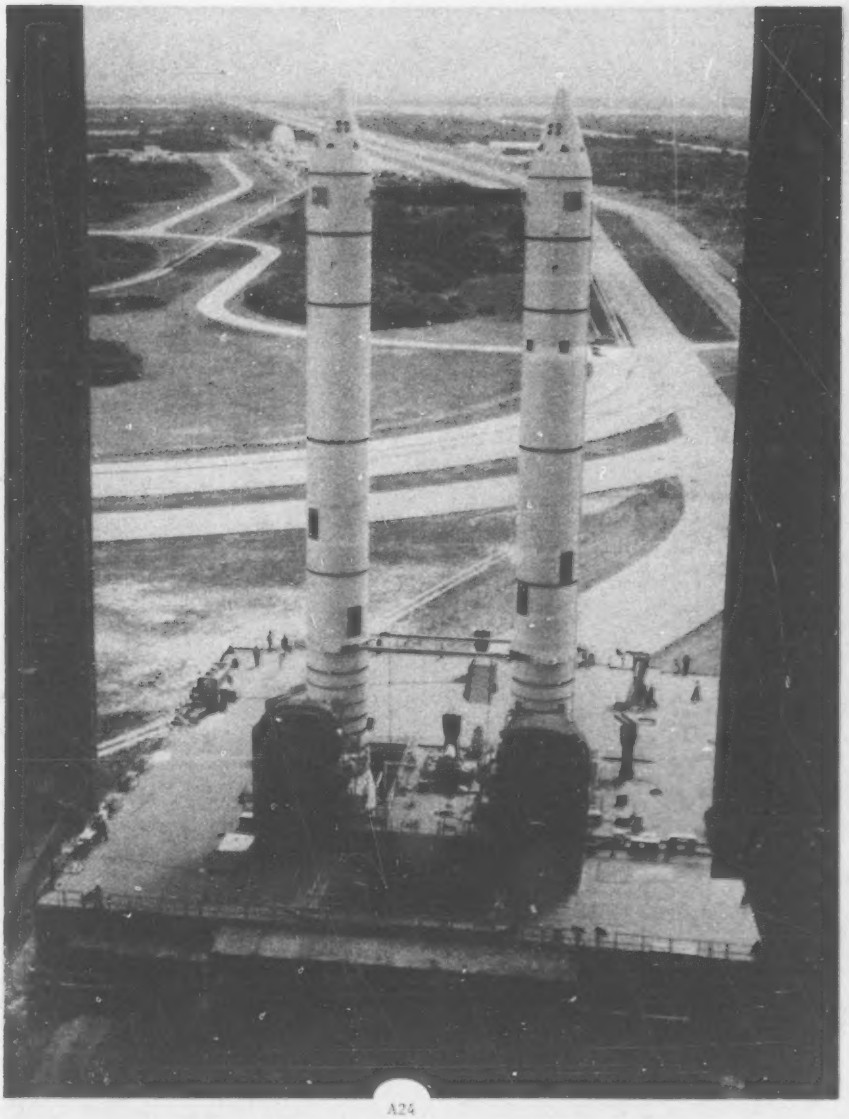
LA2
2-15-82

SPACE TRANSPORTATION SYSTEM

MPT SF-13 THRUST PROFILE FLIGHT NOZZLES




NASA
National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058
NASA-S-78-4725
SPACE SHUTTLE
MAIN PROPULSION TEST AT NSTL
LOAD SUPPORT FRAME
THRUST REACTION POINT
(FWD SUPPORT ET/SRB)
EXTERNAL TANK
SIMULATED ORBITER
MIDBODY (BOILER PLATE)
AFT FUSELAGE (FLIGHT WEIGHT)
SSME CLUSTER
FLAME DEFLECTOR
A20



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580-39947

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A24

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S81-38927

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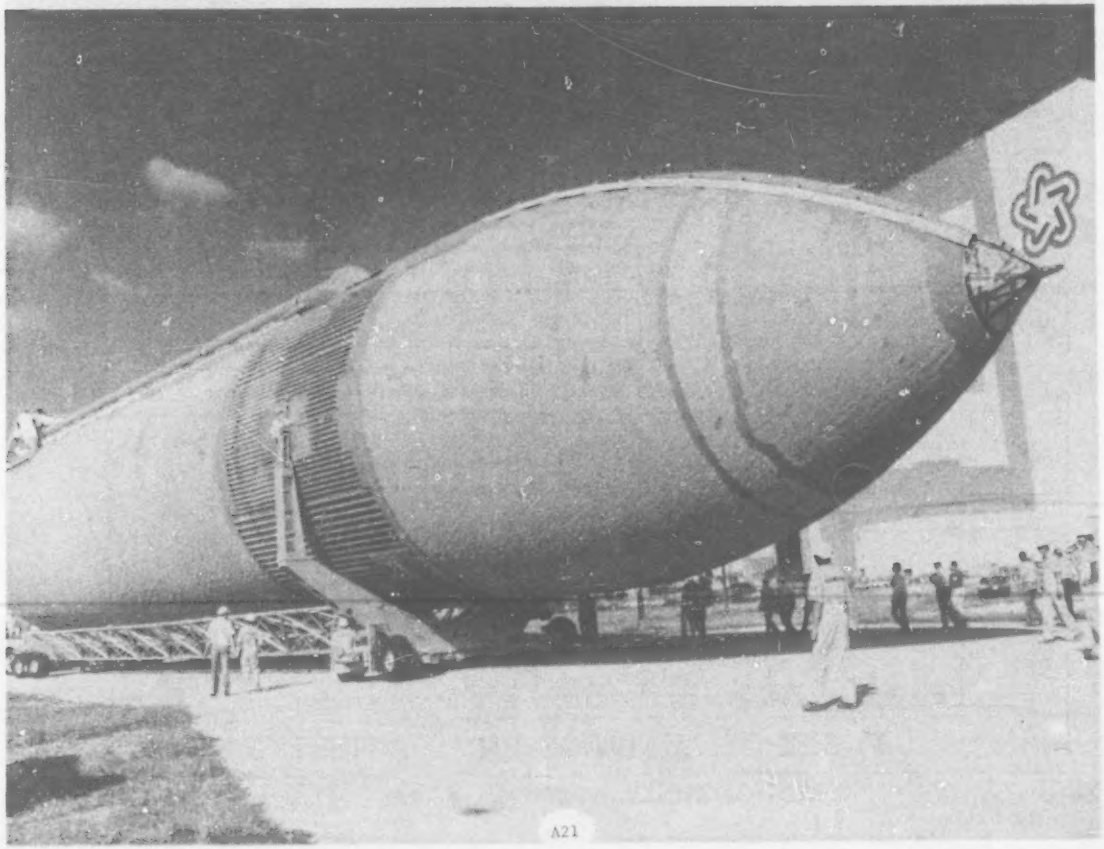


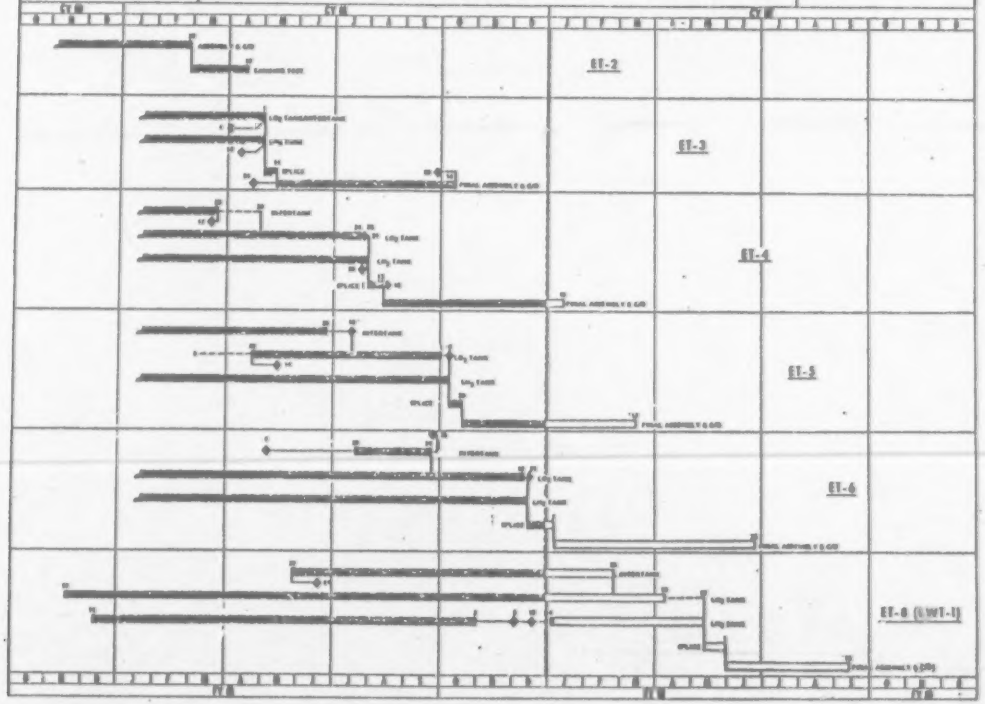
A21

NASA-S-82-10259

LA2
2-15-82

SPACE TRANSPORTATION SYSTEM

EXTERNAL TANK SUMMARY SCHEDULES



93-418 O—82——46

SPACE TRANSPORTATION SYSTEM
SRB DEVELOPMENT

- SRM/SRB PROJECT SCHEDULE
- SRB IGNITION OVERPRESSURE
- SRB PERFORMANCE IMPROVEMENTS
  - HEAVY-WEIGHT CASE-OFT BASELINE
  - LIGHT-WEIGHT CASE-STS-6 (1/20/83)
  - HIGH-PERFORMANCE MOTOR-STS-8 (7/4/83)
  - FILAMENT WOUND CASE-VLS-1 (10/30/85)

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S71-31764
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A25

NASA-S-82-10249

LA2
2-15-82

SPACE TRANSPORTATION SYSTEM
SRB IGNITION OVERPRESSURE

- WTR PLAN:
  - DEVELOP OVERPRESSURE MAGNITUDE AND FREQUENCY CRITERIA FOR WTR
  - CONDUCT 6.4% MODEL TESTS TO EVALUATE PROBLEM AND VERIFY PERFORMANCE OF ETR TYPE SUPPRESSION SYSTEM
    - 10 TEST PROGRAM USING 6.4% SCALE MODEL, TOMAHAWK MOTOR
    - TEST DELAYED APPROXIMATELY 5 WEEKS DUE TO PROBLEM ENCOUNTERED WITH WTR WATER INJECTION SYSTEM
  - CONDUCT ACOUSTICS TESTS WITH 6.4% MODEL, USING SIMULATED SRMS AND SSME'S
- ETR ACTIVITY:
  - BASELINE STS-2 CONFIGURATION SUPPRESSION SYSTEM
  - ADDITIONAL FACILITY INSTRUMENTATION TO ASSESS WATER INJECTION AND WATER TROUGH RELATIVE AFFECTS

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S81-34517

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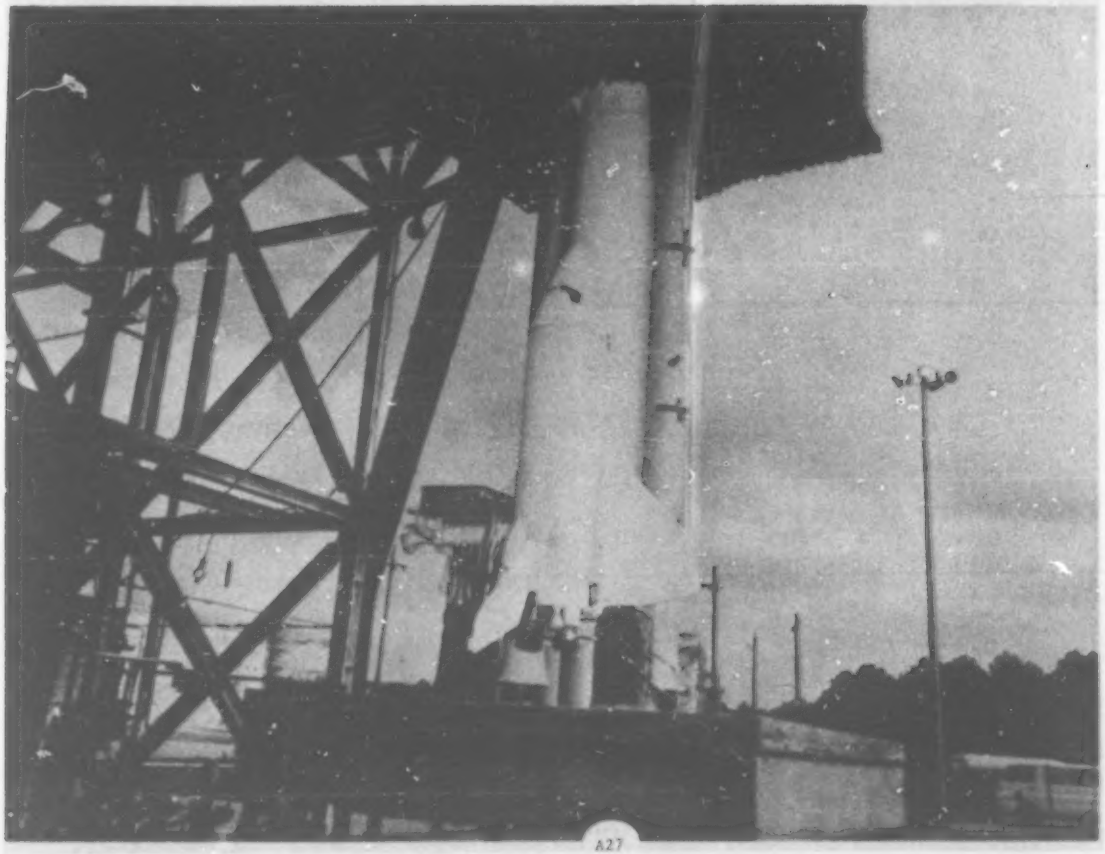

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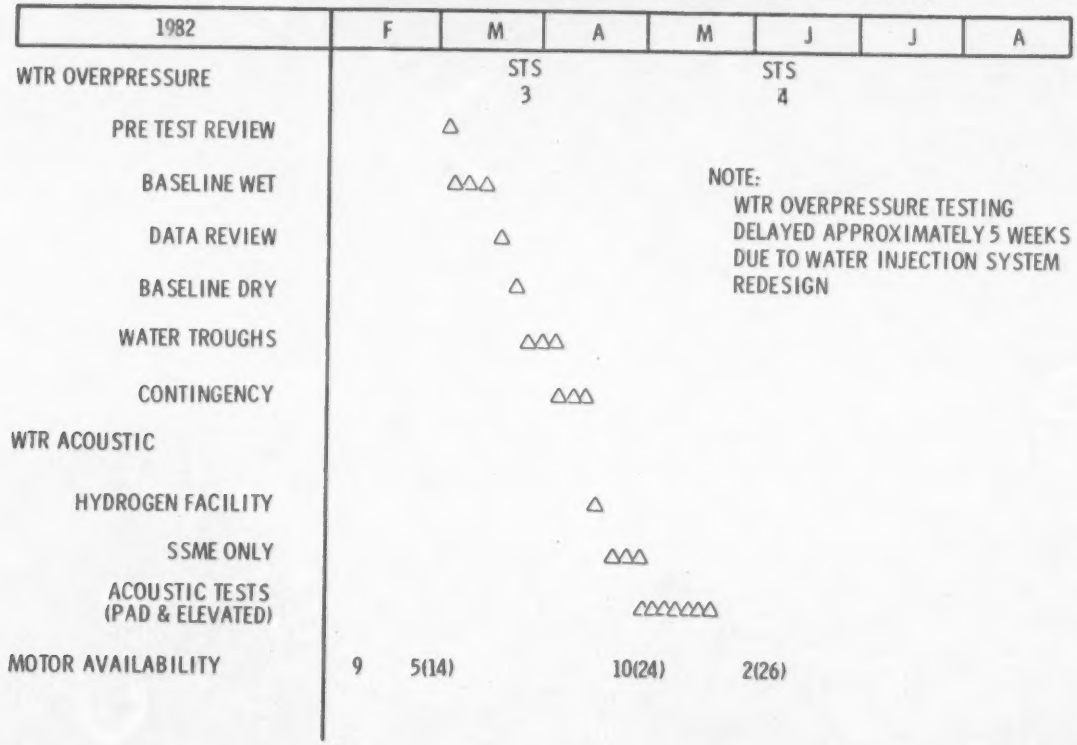
NASA-S-82-10233

SPACE TRANSPORT SYSTEM

LA2
2-15-82

WTR OVERPRESSURE/ACOUSTIC TEST PLAN



NOTE:
WTR OVERPRESSURE TESTING DELAYED APPROXIMATELY 5 WEEKS DUE TO WATER INJECTION SYSTEM REDESIGN

720

SPACE TRANSPORTATION SYSTEM

SYSTEM INTEGRATION

- KSC LAUNCH AND LANDING PROJECT

• OPF BAY 2 OPERATIONAL	JUNE 30, 1982
• LCC CONTROL ROOM 2 UPGRADED TO SUPPORT TWO-IN-FLOW PROCESSING	JUNE 30, 1982
• MLP-2 OPERATIONAL	SEPTEMBER 1, 1982
• VAB HIGH BAY 1 AND 2 OPERATIONAL	SEPTEMBER 1, 1982
• LCC SECURE FIRING ROOM	DECEMBER 31, 1982
• LCC LPS SOFTWARE PRODUCTION FACILITY CAPABLE OF TWO-IN-FLOW SIMULTANEOUSLY	OCTOBER 31, 1983
• SRB PROCESSING FACILITY (PHASE I)	JANUARY 31, 1984
• LAUNCH PAD B OPERATIONAL	JUNE 30, 1986

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SR1-26490

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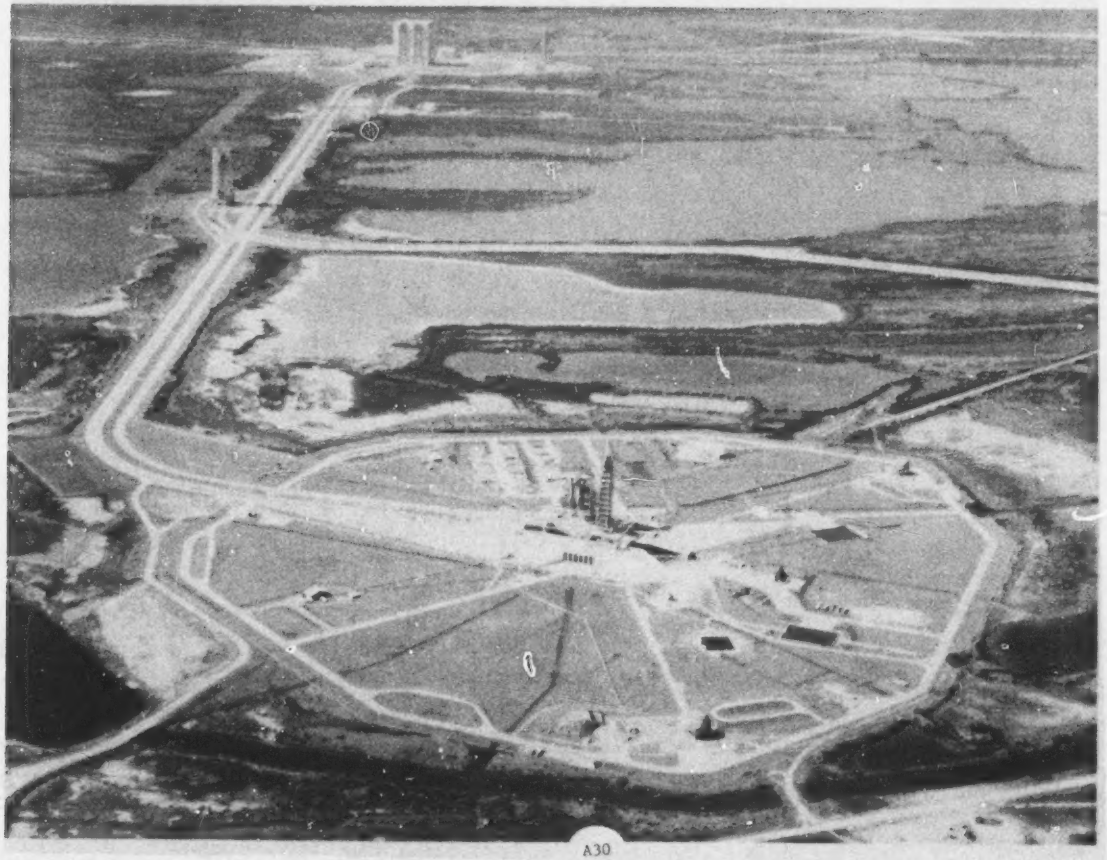

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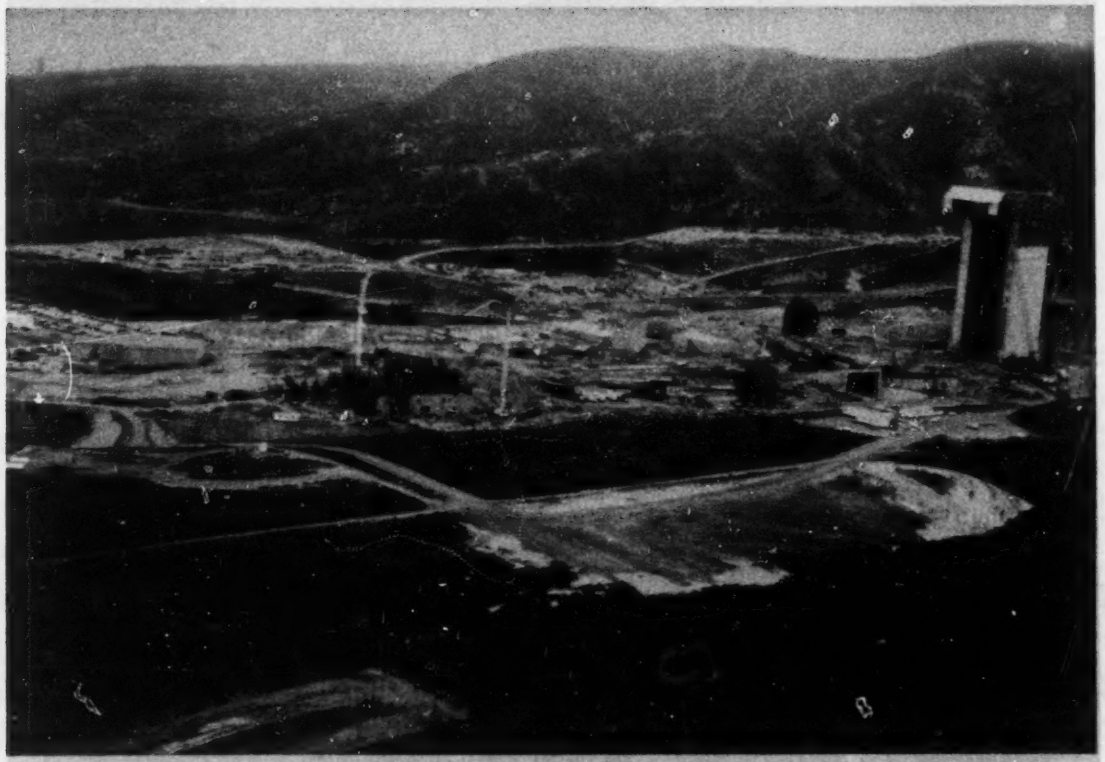

STS VANDENBERG AFB SUPPORT

A31

NASA-S-82-10262

LA5/LO/HOOVER
2-15-82

SPACE TRANSPORTATION SYSTEM
OPERATIONS & TRAINING
OFT

- STS-1 AND 2 DEMONSTRATED ADEQUACY OF OPERATIONS, TRAINING AND SUPPORT FACILITIES FOR SHUTTLE FLIGHT TEST OPERATIONS
- FLIGHT CREWS FOR STS-3 AND 4 IN FLIGHT SPECIFIC TRAINING
- THREE FLIGHT CONTROL TEAMS THAT SUPPORTED STS-1 AND 2 WILL SUPPORT STS-3 AND 4. TWO NEW FLIGHT DIRECTORS IN TRAINING WILL SUPPORT STS-3 AND 4
- ALL TRAINING FACILITIES IN PLACE
  - 2 SIMULATORS (FIXED BASE AND MOTION BASE)
  - 2 SHUTTLE TRAINING AIRCRAFT (STA)
  - SINGLE SYSTEMS TRAINER (STS)
  - 1G TRAINER, WEIGHTLESS ENVIRONMENT TRAINING FACILITY (WETF), MANIPULATOR DEVELOPMENT FACILITY (MDF)
  - SELF STUDY MATERIAL
- MCC OFT CAPABILITY IN PLACE
  - 2ND FLOOR MOCR AND SUPPORT ROOMS
  - JSC PAYLOAD OPERATIONS CONTROL CENTER (POCC) FOR OFT
- GSTDN SITES (INCLUDING INDIAN OCEAN SITE) OPERATIONAL THROUGH OFT
  - DAKAR TO BE ADDED

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S81-39409

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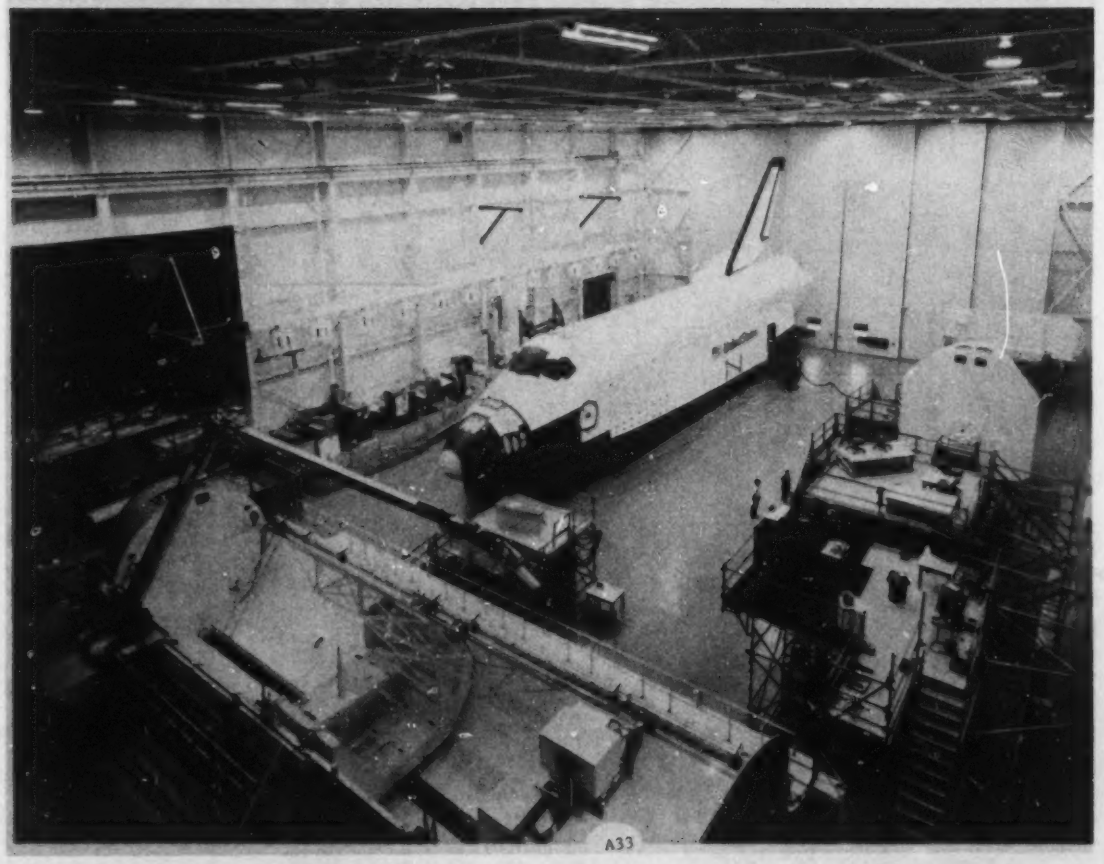


A33

Mr. BOSTICK. (Viewgraph B.) OK. I would like to report to you in general on our status in getting ready for Space Shuttle operations.

We've made a lot of progress, I think, since a year ago when we talked to you about that subject.

(Viewgraph B–1.) I would like to, first of all, bring you up to date on our payload integration activities that have been going on for a number of years in the background—they haven't been quite as visible as some of the other things. I will also bring you up to date on the latest projection of the flight or traffic model that we're going to be flying and tell you our status of implementing the facilities here at JSC that are necessary to handle that flight rate.

(Viewgraph B–2.) If you look through the first 40 flights that we have scheduled, which takes us into fiscal year 1986, we're talking about a total number of 92 payloads that are going to be manifested on those flights; 29 of those 92 are NASA, 49 are either commercial or foreign, just about evenly split, and the remaining 14 are Department of Defense payloads.

Of that total of 92, we have been working with the customers to produce in writing what we call a payload integration plan. This is a contract with the users that establishes exactly what we're going to do and what they're going to have to do to fly on the Shuttle. We have 45 of those plans or contracts finalized at this stage, another 18 actively in work, or in various stages of development, and the remaining 29, because they are further downstream in the 1985 and 1986 time period, have yet to be started.

(Viewgraph B–3.) Out through 1987, on a total number of 72 flights, we have 125 payloads. Of that 125, 42 are NASA, 30 are commercial, 28 are foreign and 25 are Department of Defense payloads. You can see the annual spread of those numbers. Again, these are payloads and not number of flights. The two here in 1982 are the remaining two OFT flights, the STS–1 and STS–2 flights aren't included. Of course we flew the first flight in 1981 and we will fly a total of three flights in 1982.

(Viewgraph B–4.) Here is a different breakdown of the same number of payloads over those years, but divided by class of payloads. You can see, of the 125 payloads that by far the majority of those are communications satellites. The next largest group are military and we have 15 that fall in the category of physics and astronomy and 11 of them are considered to be application satellites.

Congressman FUQUA. You won't have any more life sciences than just the two?

Mr. BOSTICK. That's all we have in the model right now out through 1987. Those are dedicated life science payloads.

Congressman FUQUA. On all of them or some of them?

Mr. BOSTICK. (Viewgraph B–5.) Those are major payloads. One of the things that is of great interest to us when we start planning for the conduct of all these flights is how complex they are. It greatly affects the training that we have to do to get ready to fly, both the crew training and the ground crew training. It also has an impact on the software production, the orbiter software that it takes to fly those missions, and the ground flight to flight reconfigurations.

In our latest projections, about 26 percent of those 72 flights out through fiscal year 1987 are considered to be highly complex

flights. That is, it's either the first time that we are flying an orbiter vehicle, the first time that we fly a major new payload like the tracking and data relay satellite, Spacelab, or a DOD control mode flight.

Fifty-seven percent of them are considered to be of medium complexity. That would be usually the second flight of a major payload, but still a fair amount of activity would be required to get ready for those flights. Only about 17 percent are routine, repeat flights that should require a minimum amount of crew training, reconfiguration of the simulator or the control center. Over the past 7 or 8 years that we have been planning for operations we have been keeping track of this complexity factor. We had originally projected that the division of complexity between the high, medium, and low would be about equal, about one-third each. As we get close to the flights, that is not the case, we are running into more of what we consider high and medium complexity flights than what we had originally anticipated.

(Viewgraph B–6.) If you look back over all of the years that we have been tracking our traffic model, there have been some changes in the mix of the types of flights that we're planning and as this chart points out rather vividly, I think the largest change has been in the NASA flights. There has been, over the years, some fluctuation in the number of DOD flights but it's remained essentially the same.

The same is true for the foreign customers, other Government agencies and the commercial payloads. We had a initial jump between 1974 and 1976 but that has just about stayed the same. Since then the biggest change has been in the number of projected NASA flights, and that's come down rather drastically over what we had originally anticipated, but over the last 4 years or so, it's remained about the same. We are now projecting just about an equal number of DOD and NASA flights.

(Viewgraph B–7.) Our new traffic model carried out through 1994 looks like this now. Of course, we gradually build up the flight rate until in 1988 we get up to 24 flights a year and then sustain that rate over the next few years.

As I've mentioned to you before, we carry in our model a number of reflights in case we have to refly a payload. We guarantee a reflight so we have the capability to accommodate that should the need arise.

(Viewgraph B–8 through B–14.) I'll walk you rather quickly through the airplane charts that you've all seen before, and make a few comments as we go along.

On flight 3 coming up in March we're going to fly our second major payload. It's another NASA payload, sponsored by our Office of Space Science and Applications. It is an outward looking payload as opposed to the OSTA–1 that we flew on the second flight which looked primarily toward the Earth. We are of course, still carrying out development flight instrumentation package on that flight also.

The fourth flight coming up in July will be our first Department of Defense payload and we'll be flying that before we have all of our facilities complete for what we call control mode, which is our completely secure operation. I'll talk a little bit more about that later, but because we are flying the first DOD flight before all the

facilities are completely implemented, we've had to make some special arrangements with the Air Force on special ground rules for how we will be able to conduct the flight in as secure an environment as we can without those facilities. We now have agreement with the Air Force on those ground rules.

We have also made a lot of progress, I think, on how we're going to jointly conduct the operation and how the Air Force is going to interface with us in real time. I think over the past few years, and last year especially, we have gone a long way in developing mutual trust between us and the Air Force. That relationship is now working out pretty good.

What we usually call our first operational flight, STS–5, is scheduled for November of this year. Our current assessment is, that we may be able to fly that flight as much as a month earlier. The people at the Cape have just recently completed an assessment of their current activities between flight 3 and 4 and flight 4 and 5. With the experience they've had in doing that a couple of times, they think they can beat what they were originally projecting. There's a good possibility, that we will come very close to meeting our original objective, of conducting the first operational flight by the end of fiscal year 1982. We won't miss that too much. Shortly after that, in the early part of calendar year of 1983, we will fly the first tracking and data relay satellite. That's a major mission for us. It's certainly one that we would categorize as highly complex and operationally is the first flight of OV–099. It involves tying our control center here in with the Air Force Control Center in Sunnyvale and the TDRS ground station at White Sands.

We just recently completed what we call a cargo integration review for that flight, where we review the overall status of preparation for a flight that's usually a year to 18 months away. Our assessment is that even though it's a highly complex flight, we're in relatively good shape in preparation for it.

Congressman FLIPPO. Are there any new lift capability requirements imposed on you as a result of that or are there any accelerated lift requirements?

Mr. BOSTICK. No. For flight 6 with the hardware that we have in the inventory now and coming down the pike, we're in pretty good shape performancewise or lift capabilitywise.

Dr. LUNNEY. We could use 102 percent, not 109 for that flight. Is that what you meant? I'm not sure.

Congressman FLIPPO. Yes.

Congressman FUQUA. Jerry, if you move up STS–5, you say you may launch a month earlier, would that affect any of the down range schedules being moved up?

Mr. BOSTICK. It possibly would. Just last week I sent out a letter to all of the customers that are on the flights up through 6, advising them that there was some possibility that their flights could be accelerated and asking for their assessment of their ability to meet that. For example, if we are able to move flight 5 up, our projections are that we would also be able to do the same for STS–6.

Congressman FUQUA. Would OV–099 be ready by that time? I know it's ready to be delivered on time.

Mr. BOSTICK. Yes. We're projecting now to deliver OV–099 in June. In our discussions with the people at the cape last week, they

say that they could still accelerate flight 6 assuming we have no problems on 3, 4 and 5, even if the delivery of OV-099 were delayed as much as 6 weeks or 2 months.

Congressman FLIPPO. Don't you have to have the filament line case for No. 6?

Mr. BOSTICK. No.

Congressman FLIPPO. You do not?

Dr. LUNNEY. That's scheduled in 1985.

Congressman FLIPPO. That's 1985?

Dr. LUNNEY. Yes. You know, I don't think we should look at these schedule changes as something that's happened. As these schedules go, arguing about 1 week or 2 is somewhat fuzzy. I think you ought to think of it as a measure of the confidence that the team has in their measure of the work. That's the way I look at the thing. When the people start calling, George Page called on STS-4, and said that he felt he had a good shot at moving that date in July back 10 days, and he said, "Do you want me to work on that?" Well, you know, the answer is "Damn right." It's a measure of confidence and maturity, I think, and some comfort to people that we may actually get there.

Dr. Kraft says maybe I'm being too bullish about that. Maybe we are, but as a measure of the team's understanding of the work, I think that's a pretty good indicator.

Congressman FLIPPO. The perspective I look at it from is as far as its budget ramifications of the project.

Dr. LUNNEY. It tells you in the near term that you have a little flexibility to deal with overtime.

Mr. BOSTICK. And that's a way that you could possibly use that margin, not have to spend as much on overtime.

Congressman FLIPPO. Well, if you use it, you lose it for all times, don't you?

Dr. LUNNEY. Yes, sir.

Mr. BOSTICK. It's certainly a better posture to be in than if we were predicting now that we were going to be hard pressed to meet the schedule. It wouldn't be our intent to announce any official changes in those dates until after flight 3. There certainly are a few "if's" in getting flights 3, 4, and 5 off on schedule without any major hitches, but it is a comfortable position to be in.

Dr. KRAFT. Well, I think STS-6 is going to be particularly difficult from an operational point of view, when you tie all those new elements into the operation the first time you fly. It's the first time you're going to have an Air Force flight control team to run the IUS. Getting that whole training situation tied together is just going to be a big mouthful.

Congressman FUQUA. Crucial mission too.

Dr. KRAFT. Yes, sir.

Dr. LUNNEY. The practical thing about it is it's scheduled for the 20th of January. For human reasons you can only move that so close to New Year's Eve or New Year's Day and be comfortable. I think you're going to assume the team has some time off for Christmas, a little time to get everybody back into the routine before you can schedule the next flight. So I think you would want to maintain some buffer there between the flight schedules for STS-5 and STS-6.

Congressman FUQUA. Then you've got the election too.

Dr. KRAFT. If you could do STS-5 early, then you could get OV-102 back in the factory, modified, and back to the cape. That would be the real feather in your cap.

Congressman FUQUA. The optimistic scenario, if you were able to get it off a month ahead, would they be able to accept it to start work on it at that time? They would know enough ahead of time, though, that they could program that in.

Dr. LUNNEY. Yes.

Congressman FLIPPO. Has the decision been made on where you're going to land flight 5.

Dr. LUNNEY. We've made one. We might change it but we decided we're going to land at the cape on flight 5.

Congressman FLIPPO. And then you'd transport to Palmdale for refitting?

Dr. LUNNEY. Yes. As a matter of fact, we actually considered landing at Edwards because intuitively it seems like it would be better to land at the factory or at least close to it, but we would then have had to split the cape forces, while they're at work on OV-099. We'd have to take a fair number of people out and go through the deservicing. You have to get all the propellants and liquids off the vehicle. Dryden is not configured to really do that. The factory at Palmdale has to accept the vehicle without any propellants on board. The cape actually felt like it would be better to land it where they were rather than to land it at Dryden.

Congressman FLIPPO. The question is whether you're going to take Mohammed to the mountain or the mountain to Mohammed?

Dr. LUNNEY. Yes, sir.

Mr. BOSTICK. The rest of the flights in 1983, after the TDRS, the next big major flight for us, is the first Spacelab flight that is scheduled in September. That's going to be the first time that we use our payload operations control center here on site. We will have several hundred investigators who will be in the control center which is a major milestone for us in terms of how we deal with those people, and in supporting them with the facilities that we have.

Immediately after that is our first control mode flight for the Department of Defense which is another biggee in that year. It's scheduled for November of 1983.

Then in December we have the flight that goes up to repair or return the Solar Max spacecraft. We, as Dr. Lunney mentioned, are looking at the possiblity of delaying that flight either 3 or 6 months. We aren't spending a lot of effort on planning for that flight right now.

The chart shows the OMS kit being used. We have since determined that we could do that flight without the OMS kit. In fact our plan now is that if the mission is approved we would not develop the OMS kit but use what we call a direct insertion technique where we would target the ascent to have an apogee altitute that's near the altitude of Solar Max. That requires dropping the external tank over in the Pacific near Hawaii which had given cause for some concern before, but after looking at that technique over the past few months, we have determined that it is by far the best way

to go. Budget wise, it's quite a bit less expensive than it would be if we had to accelerate the development of the OMS kit.

So, if we do that flight, we're looking at conducting it in the March to June 1984 time period. Our plan would still be to take up the long duration exposure facility payload on that flight and leave it in orbit before we begin to do the repair on the Solar Max.

Congressman FLIPPO. You're going to need the OHMS kit for the telescope?

Mr. BOSTICK. No, sir. Our plan now would be to use the same direct insertion technique that we're talking about for the Solax Max mission. Those two missions are coupled in our current planning. If we do go up and repair the Solar Max, we would leave the LDEF there, then on the Space Telescope flight we would first deploy the Space Telescope, and then retrive the LDEF. But the answer is no, we would not require on OMS kit for that. We would use the direct insertion technique.

Here you see a lot more communications satellites; Satellite Business Services along with Syncom on flight 16. Two more communication satellites on STS–17 and some room for what we call a payload of opportunity.

What is called Spacelab 3 but will actually be the second Spacelab flight, then would be in September of 1984 with Spacelab 2, or the third Spacelab flight, in November of that year.

The Space Telescope, which again is coupled with the LDEF return, would be in January of 1985.

The first commercial Spacelab flight, designated D–1, is currently scheduled for April of 1985.

As I think you know, our plan is to fly a total of 32 flights up through fiscal year 1985. On our current manifest we are carrying two optional Department of Defense flights numbers 27 and 30. That makes the total number through that period come out to 34, but we will actually fly only 32 flights. We're only buying SRB's and tanks, et certera, to support 32 flights. When this plan which included these optional DOD flights was laid out, we really didn't know the status of those flights and how long we would have to maintain the planning for them.

(Viewgraph B–15.) I will run very briefly over the status of our facilities at JSC that we are in the process of implementing to get ready for what we call mature operations. We will have what we call control mode to conduct the Department of Defense flights within a secure environment. This involves some modifications in the control center, building 30, and in our simulators, as well as some electronic modifications to the computers in those two facilities.

That's scheduled for completion now in time to support the first control mode flight in fiscal year 1984. We think we are well along the road to meeting those milestones, and I'll give you a few more details on that in a minute.

Out payload operations control center which is scheduled to support the first Spacelab flight is also on schedule. I think we're in good shape there.

In April 1984, we will have dual mission support capability in the control center. (Viewgraph B–16.) Our basic Shuttle mission simulator facility is operational now. We had planned to put what

we call a guidance and navigation simulator, which is basically an aft crew station, in building 35 and use that for some of the simulator software development. The plan now is to divert or detour that aft crew station and put it over in building 5 with the motion base simulator. That is going to help us a lot in the turnaround time that's required between flights 5 and 6. We think that will be a great asset in the future as well, because of the different configurations of the aft flight deck which is used for the payload activities. We're just now beginning to implement the new aft flight deck and that's going to help us out a lot in the turnaround between flights 5 and 6.

The IUS simulator is also coming along very well. We will have it completely operational later this year in time to support the training activities for the first TDRS flight which is also the first IUS flight.

The Spacelab simulator is just a couple of months behind that and it will be ready to support the first Spacelab mission.

(Viewgraph B–17.) The controlled mode, I think you remember, involved our flight design system and our crew activity planning system, both of which are located in building 30.

It also involves sharing computers in building 12 and in building 30, which are used for data reduction and data management.

In building 5, in the simulator, we have separated the computers that support the non-DOD and DOD flights so that we can what we call a dedicatable string of computers in a secure environment. We have, of course, made some facility modifications to the visitor's entrance in building 5 as we have done in the building 30 control center.

The other modifications in building 30 were to secure the computers on the first floor that support activities on the upper floors and to secure the third floor itself, which is where we'll fly all of the control mode flights.

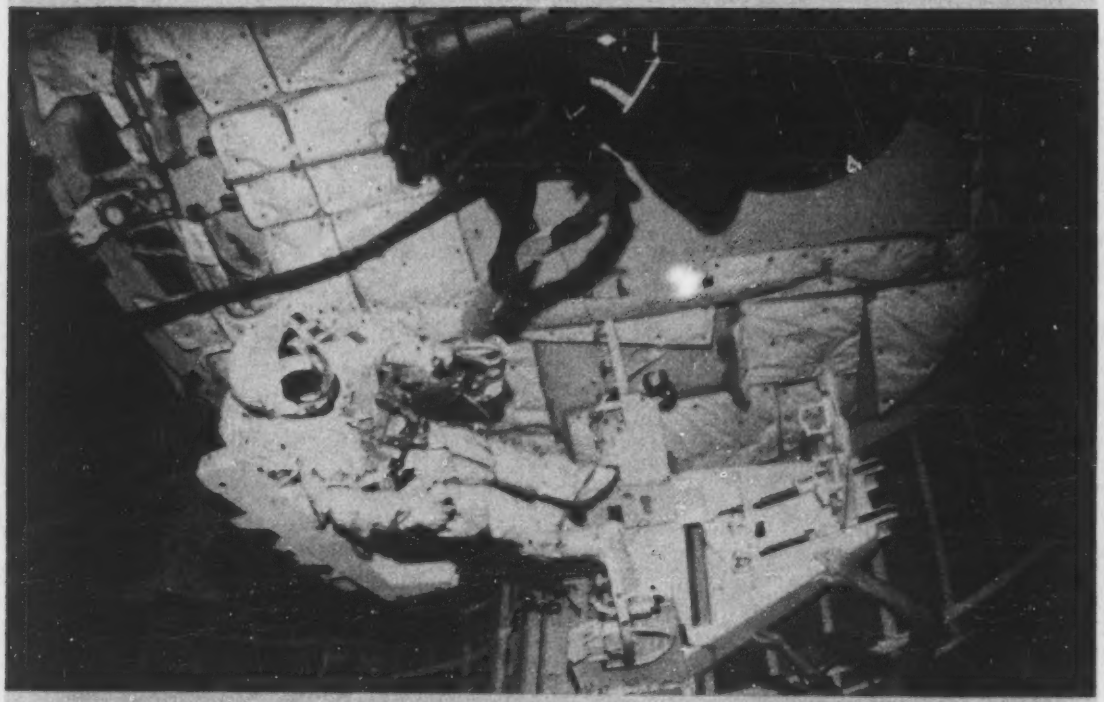
(Viewgraph B–18.) This is a schedule of the activities. Before we use the facilities to support the secure flights, we have to get approval from the Air Force on a number of the elements that fall under control mode. There are a total of 11 major elements or systems that are involved.

We now think that we are complete on five or six of those and have notified the Department of Defense that we think that we have met their requirement and are ready for them to certify those facilities for flight.

The last element under control mode, the one that will be completed and certified last, is the control center itself. That's scheduled to be completed in early 1983. That would support the first control mode flight in the fall of 1984. All of the facilities modifications that are associated with control mode are now completed. (Viewgraph B–19.) As I mentioned we have completed all that we can do in the flight design and data reduction elements of controlled mode. They are now ready for DOD certification. All of the other systems are going to be completed this calendar year. The final DOD approval should be coming forward in the spring of 1983 and all of that supports the first controlled mode flight later that year.

NASA National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058



WEIGHTLESS ENVIRONMENT TRAINING FACILITY

81-34956

A34

726

NASA-S-82-10221

LM/H.E. WHITACRE
2-15-82

SPACE TRANSPORTATION SYSTEM

EARLY OPERATIONAL FLIGHTS

FLIGHT/DATE	STS-5 NOV 82	STS-6 JAN 83	STS-7 APR 83	STS-8 JUL 83	STS-9 SEPT 83
CARGO ASSIGNED	COMMUNICATIONS SATELLITES -SBS-C PHARMACEUTICAL -MLR OTHER -GAS	COMM SAT -TDRS-A PHARM -CFES -MLR OTHER -GAS	COMM SAT -PALAPA-B1 -TELESAT-F PHARM. -CFES MATERIALS RES. -SPAS-01 OTHER -OSTA-2, GAS	COMM SAT -TDRS-B -INSAT-1B PHARM -CFES	SPACELAB -1 OTHER -GAS -OEX
DURATION/CREW	5/4	2/4	5/4	3/4	7/6
COMMENT	OV-102 TO REWORK	FIRST OV-099 FLIGHT		FIRST HI PERF SRB NIGHT LANDING	OPERATIONAL OV-102

FLIGHT/DATE	STS-10 NOV 83	STS-11 DEC 83	STS-12 JAN 84	STS-13 MAR 84
CARGO ASSIGNED	DOD	** SMM REVISIT LDEF DEPLOY OTHER -OEX	COMM SAT -TDRS-C -PALAPA-B2	DOD
DURATION/CREW		5/4	3/4	
COMMENT		DIRECT INSERTION	FIRST OV-103 FLIGHT	

* BASED ON JSC 17379, REV. B, JANUARY 20, 1982
** UNDER REVIEW

NASA-S-82-10276

LA2
2-15-82

SPACE TRANSPORATION SYSTEM
STS PERSPECTIVE

NATIONAL STS PROGRAM IS A LONG-TERM ENTERPRISE OF VITAL SIGNIFICANCE

- IT CONFERS ON US VERY SERIOUS OBLIGATIONS TO ACHIEVE AND MAINTAIN:
  - SOLID, DEPENDABLE BASE FOR NATIONAL SPACE ACTIVITIES
  - CUSTOMER SERVICING ON THEIR DESIRED SCHEDULES
    AND
  - AN APPROPRIATE FLIGHT RATE MARGIN FOR FUTURE NATIONAL OPTIONS

- IT HAS THE POTENTIAL FOR ENABLING ENTIRELY NEW ACTIVITIES
  - DEFENSE - NATIONAL SECURITY
  - COMMERCIAL - INCREASED PRODUCTIVITY AND NEW PRODUCTS
  - NASA - A NEW PLATEAU FOR EXPLORATION AND UNDERSTANDING

- IT CAN BE A SIGNIFICANT CONTRIBUTION TO OUR CAPABILITY AND SPIRIT AS A WORLD POWER

WE ARE ON THE THRESHOLD

728

I think what I said about NASA/DOD relations for flight 4 also applies to this activity that's been going on for a number of years. We have, I think, really learned how to work with the DOD in a much better manner and this overall activity has gone very smoothly in the past year. I think that flight 4 itself is going to put the icing on the cake. They're going to learn that they can trust us and we are going to learn that we can trust them. I'm not nearly as anxious about future operations with the DOD as I was a couple of years ago.

Congressman FUQUA. Let's go off the record just a moment.

[Off-the-record discussion.]

Dr. LUNNEY. I'd like to offer something. One of the things that people constantly ask us is, when are you guys ever going to do anything for operations. Now Jerry put these charts up at the beginning of the pitch that told you he's got about a hundred customers—40 that he has signed up technically, and about 20 more than he's actively working on. We have never had launch vehicle systems that ever dealt with 60 payloads at the same time. Didn't even come anywhere remotely close to that. That whole process and that whole level of activity is somewhat invisible by the fact that it works and there's not a lot of issues coming out of it and not a lot of stuff for people to manage more than the normal day-to-day work. It's really a tribute to getting the thing started and handling the customer load that needs to be handled as we move into operations. It is an example of what we're doing for operations but it tends not to be seen very well because there isn't that much traffic out of it or exceptional things out of it that go to Washington for their dispensation.

The work is being done and therefore it's slightly invisible, especially to people who ask, what are you doing for operations. End of commercial. Thank you.

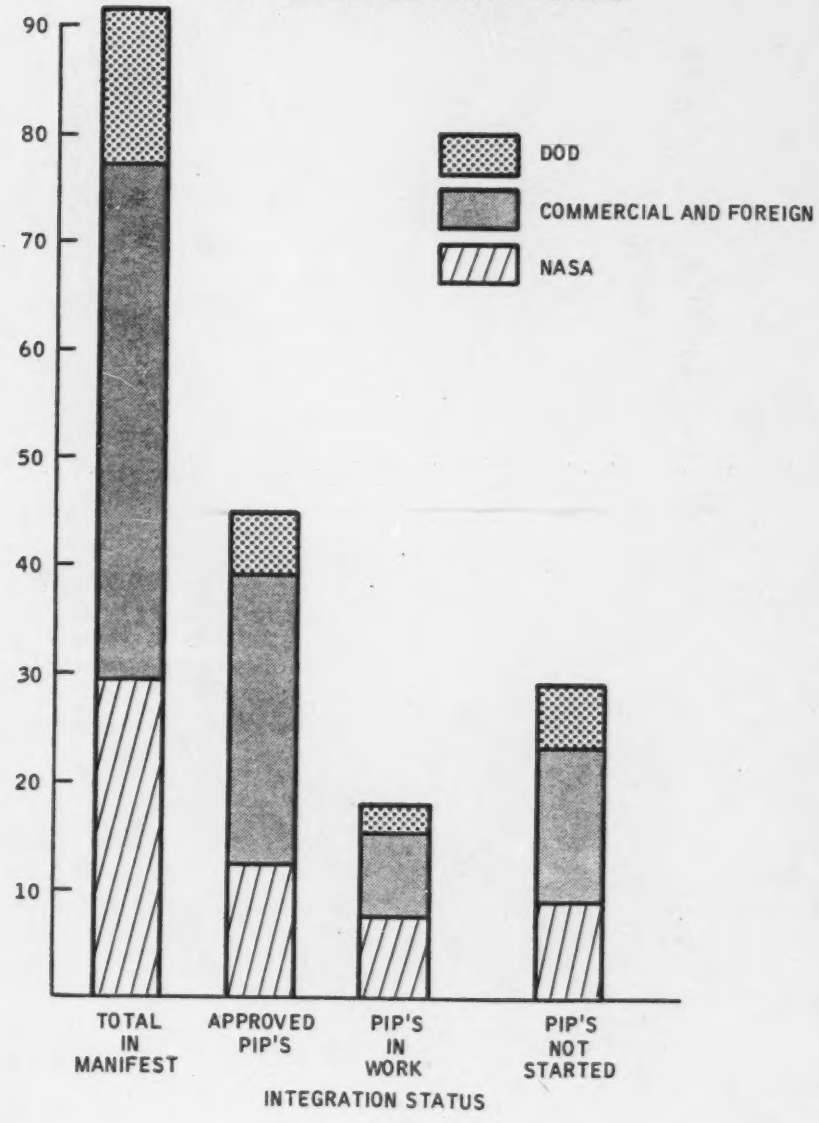
[Viewgraphs B through B-19 of Mr. Bostick's oral presentation follow:]

NASA-S-82-1015D

PAYLOAD INTEGRATION STATUS

13000-6 MANIFEST

(PROPOSED 1/21/82) (FIRST 40 FLIGHTS)



NASA-S-82-10188

SPACE SHUTTLE OPERATIONS PLANNING

737

JERRY C. BOSTICK
ACTING MANAGER
STS OPERATIONS PROGRAM

NASA-S-82-10189

SPACE SHUTTLE OPERATIONS PLANNING

- PAYLOAD INTEGRATION ACTIVITIES
- PROJECTED FLIGHT MODEL
- FACILITIES IMPLEMENTATION STATUS

NASA-S-82-10187

PAYLOAD MODEL SUMMARY

(BY USER)

	FY 82	83	84	85	86	87	TOTAL
NASA	1*	3	6	7	13	12	42
U.S. COMMERCIAL		3	10	6	8	3	30
FOREIGN		5	3	6	8	6	28
DOD	1*		2	6	6	10	25
TOTAL	2	11	21	25	35	31	125

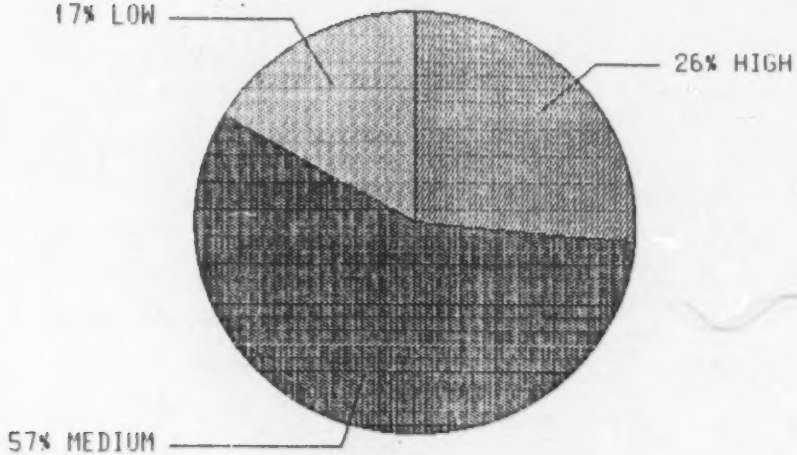
*OFT FLIGHTS

NASA-S-82-10186

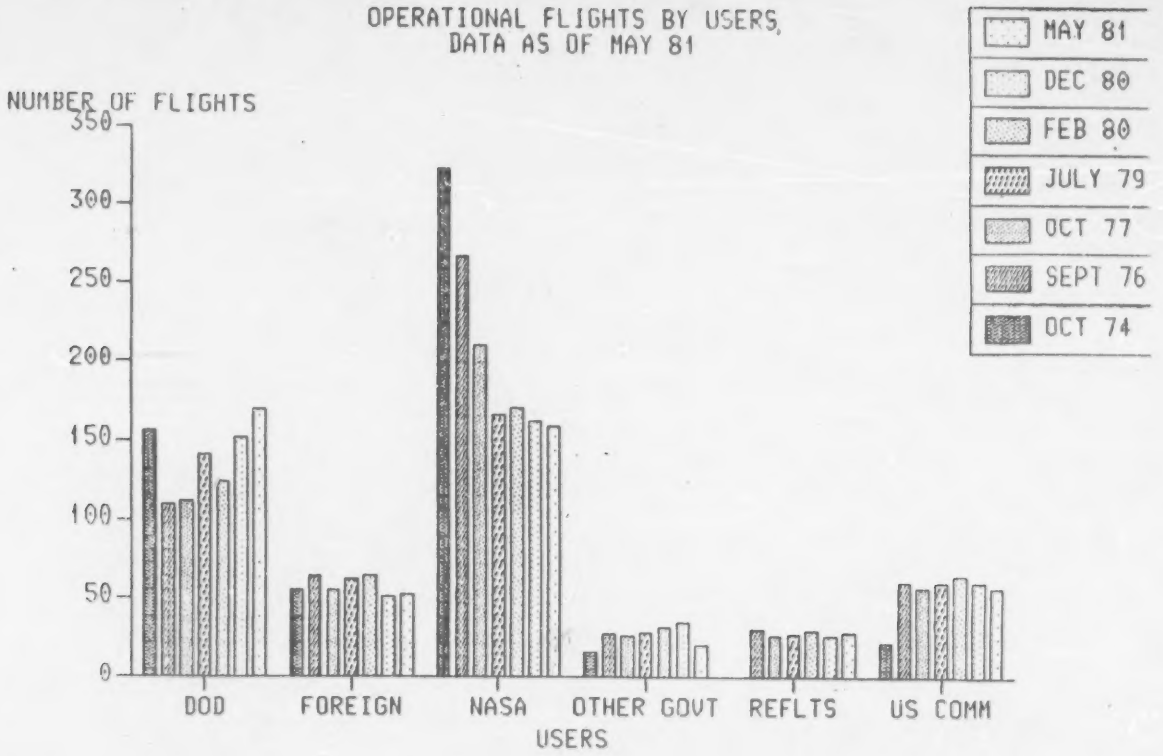
PAYLOAD MODEL SUMMARY
(BY CLASS)

	FY 82	83	84	85	86	87	TOTAL
LUNAR AND PLANETARY	0	0	0	1	1	0	2
COMMUNICATIONS	0	7	12	11	15	7	52
SPACE PROCESSING	0	2	1	1	0	3	7
TECHNOLOGY	0	0	4	1	1	1	7
APPLICATIONS	0	1	2	1	4	3	11
ENVIRONMENTAL MONITOR	0	0	0	1	0	0	1
LIFE SCIENCE	0	0	0	1	0	1	2
PHYS AND ASTR	1	1	0	2	5	6	15
EARTH OBS	0	0	0	0	3	0	3
DOD	1	0	2	6	6	10	25
TOTAL	2	11	21	25	35	31	125

13000-6 PRELIMINARY MANIFEST
FLIGHT COMPLEXITY
72 FLIGHTS THRU FY87



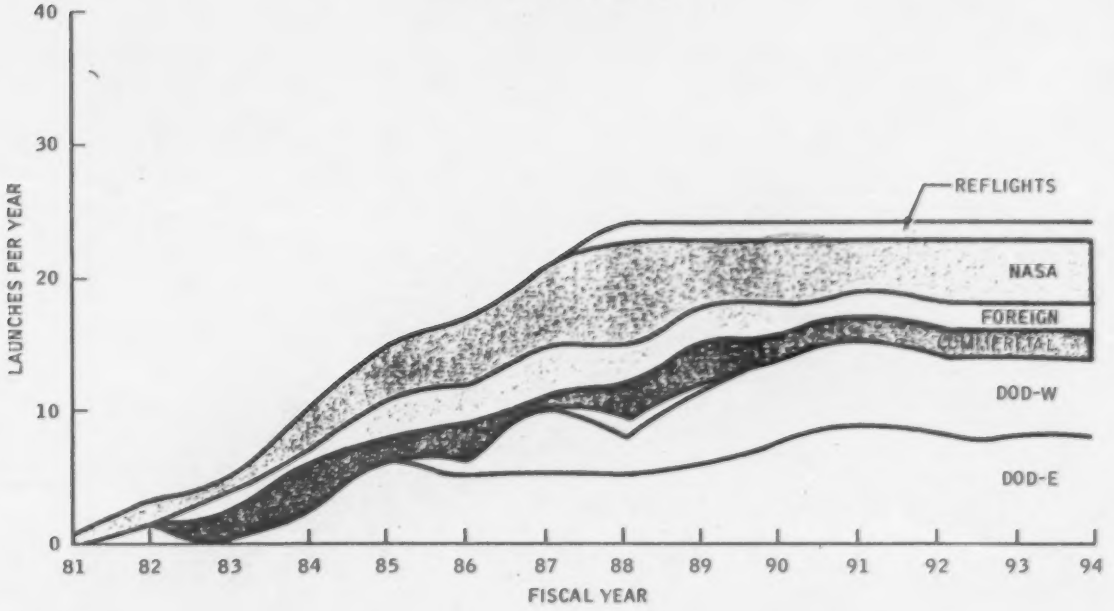
FLIGHT COMPLEXITY


OPERATIONAL FLIGHTS BY USERS
DATA AS OF MAY 81
NUMBER OF FLIGHTS
350
300
250
200
150
100
50
0
DOD
FOREIGN
NASA
OTHER GOVT
REFLTS
US COMM
USERS
MAY 81
DEC 80
FEB 80
JULY 79
OCT 77
SEPT 76
OCT 74

NASA-S-82-10183

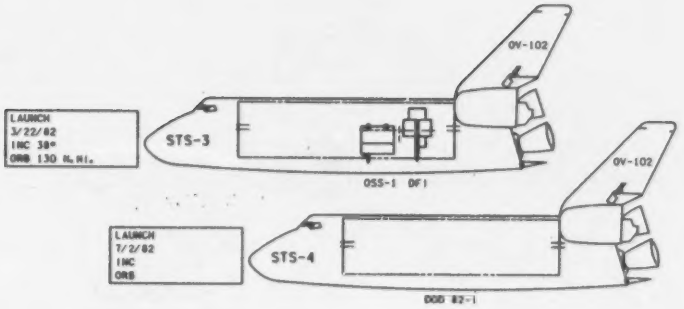
PROJECTED SHUTTLE LAUNCHES

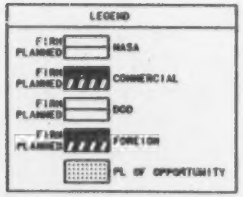
FY 1981 - 1994
2 SITE OPERATION



STS FLIGHT ASSIGNMENT BASELINE
13000-6

FEBRUARY 1982





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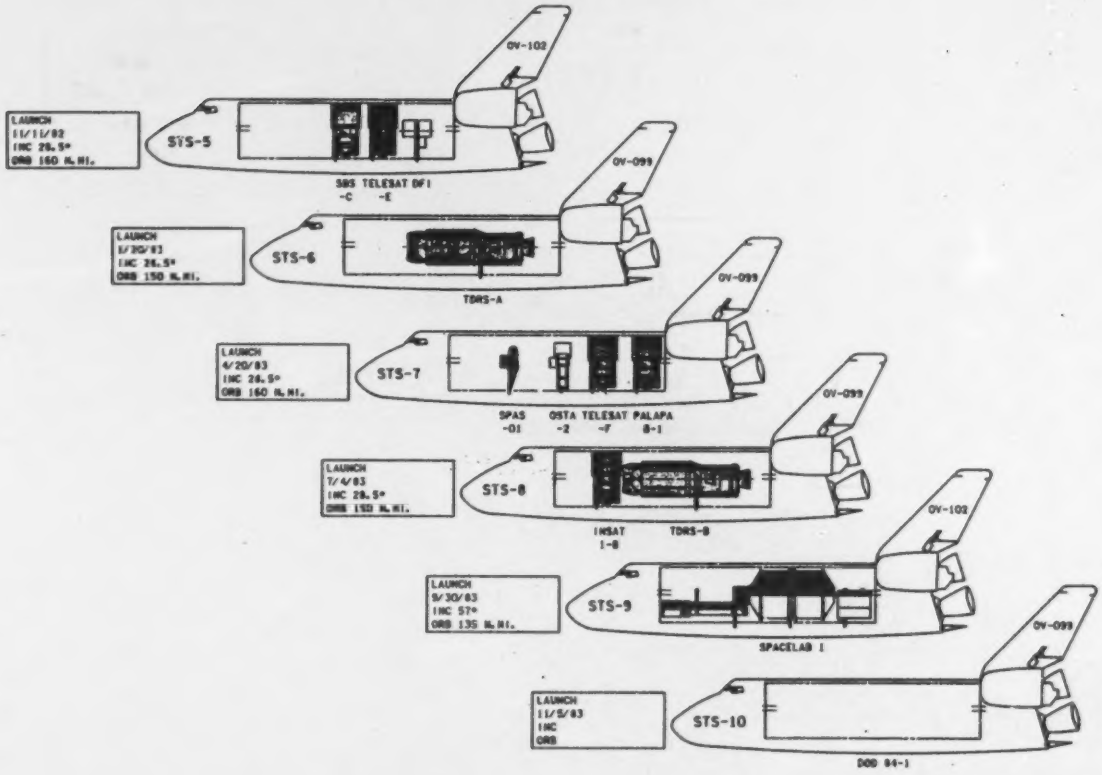

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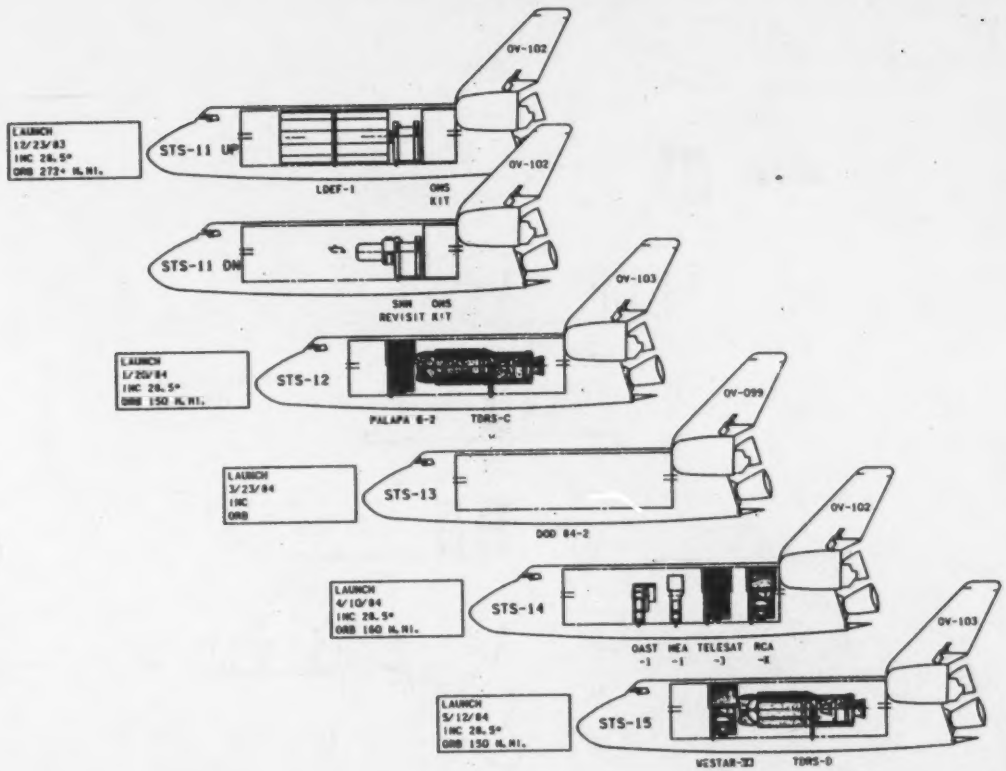

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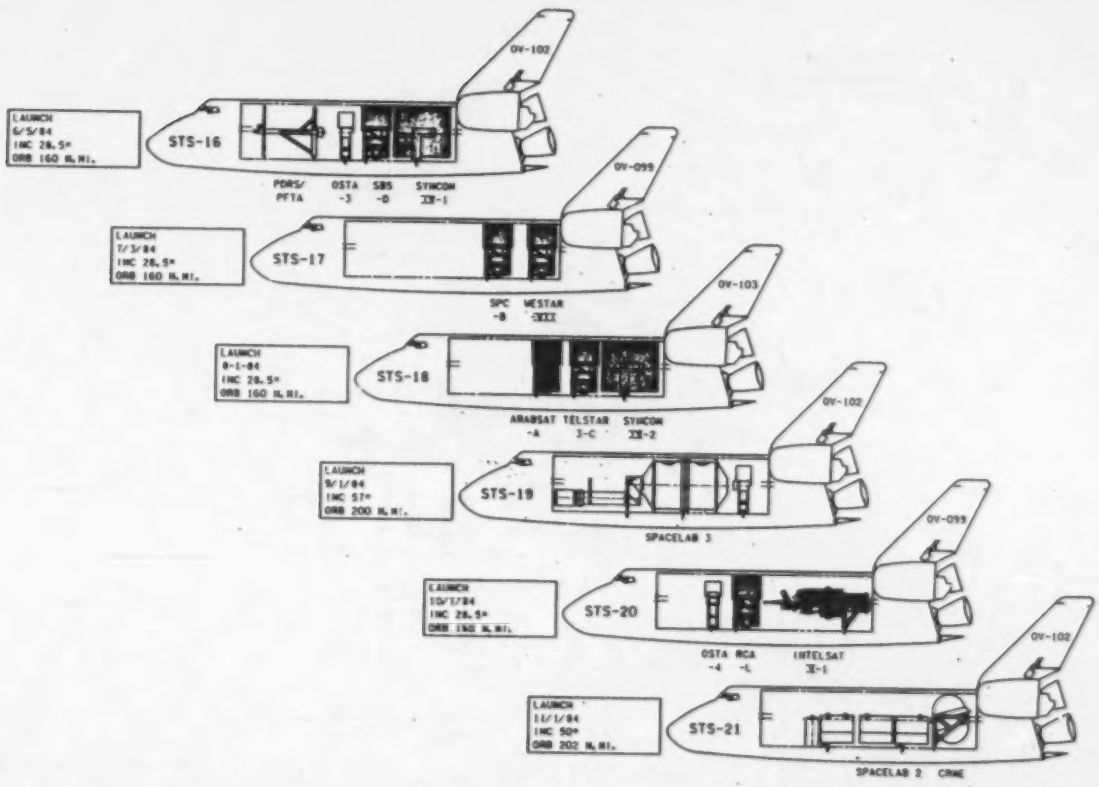

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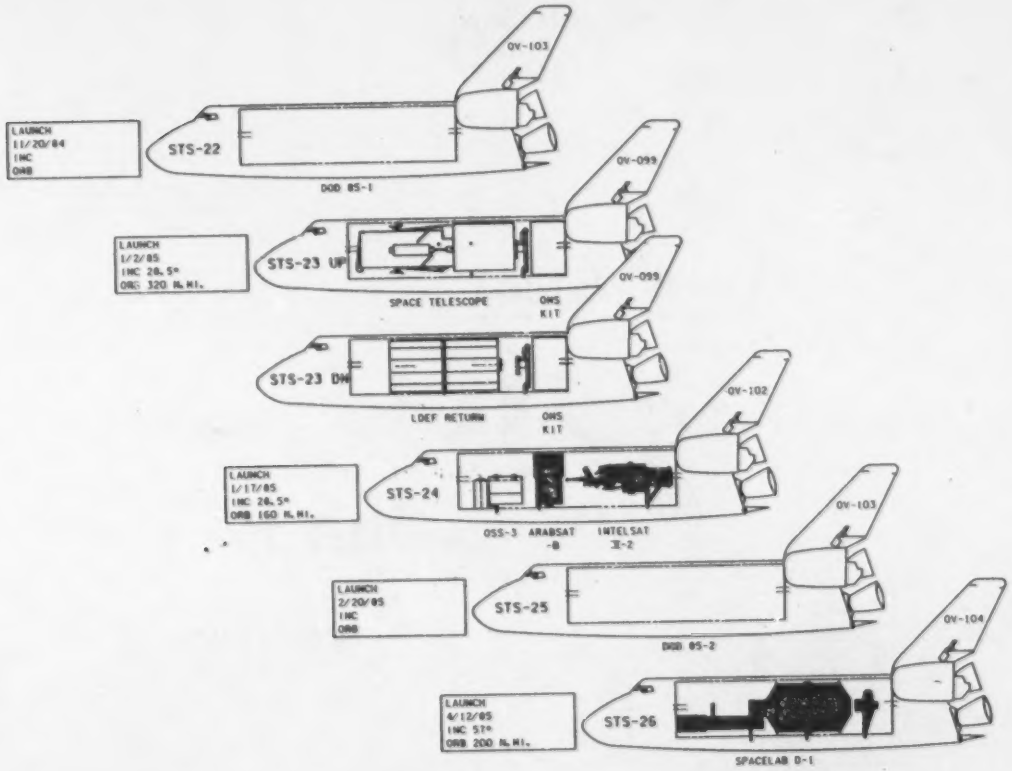

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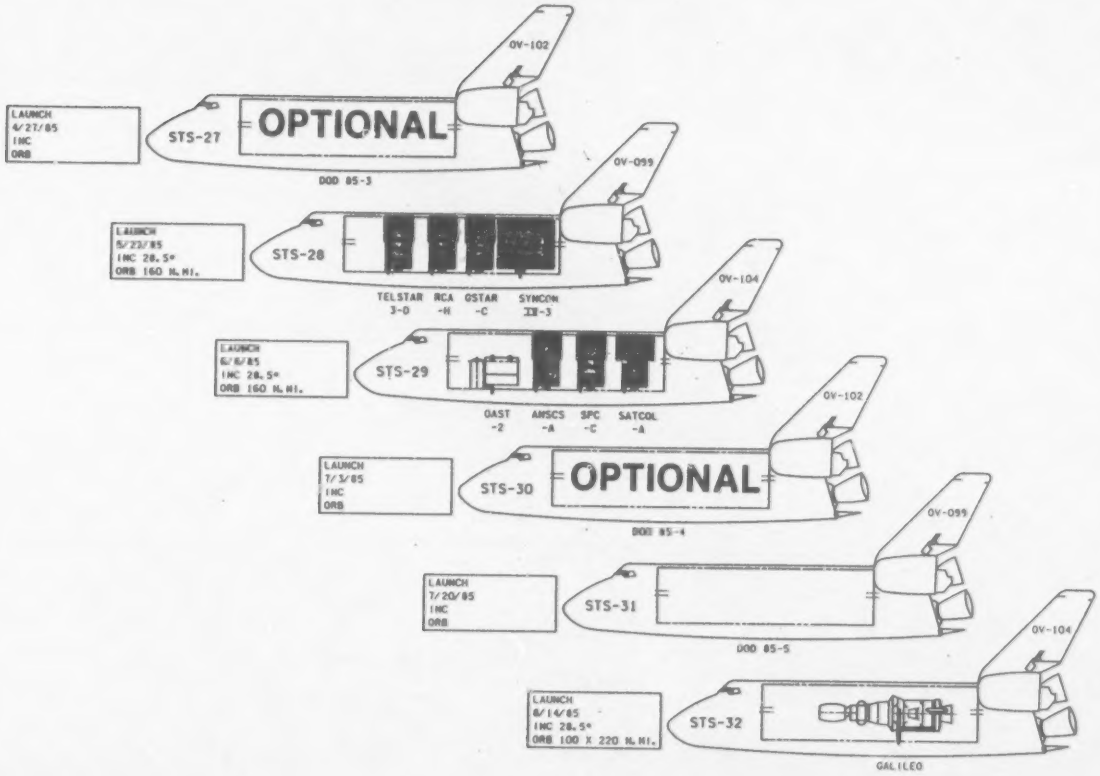

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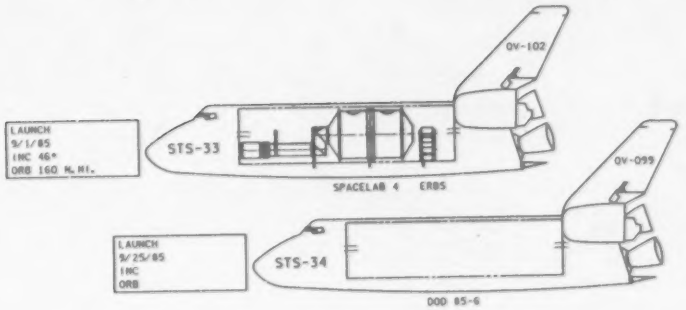
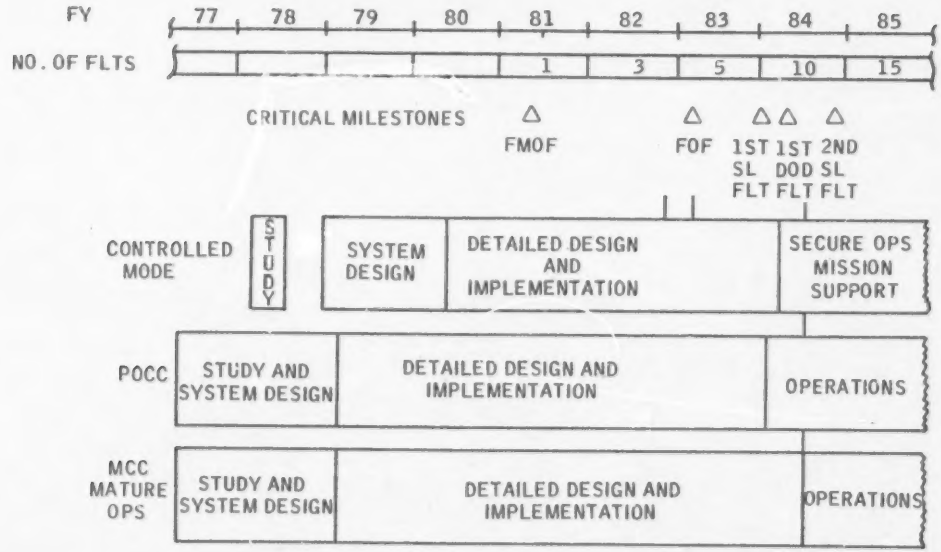
13000-6

FEBRUARY 1982



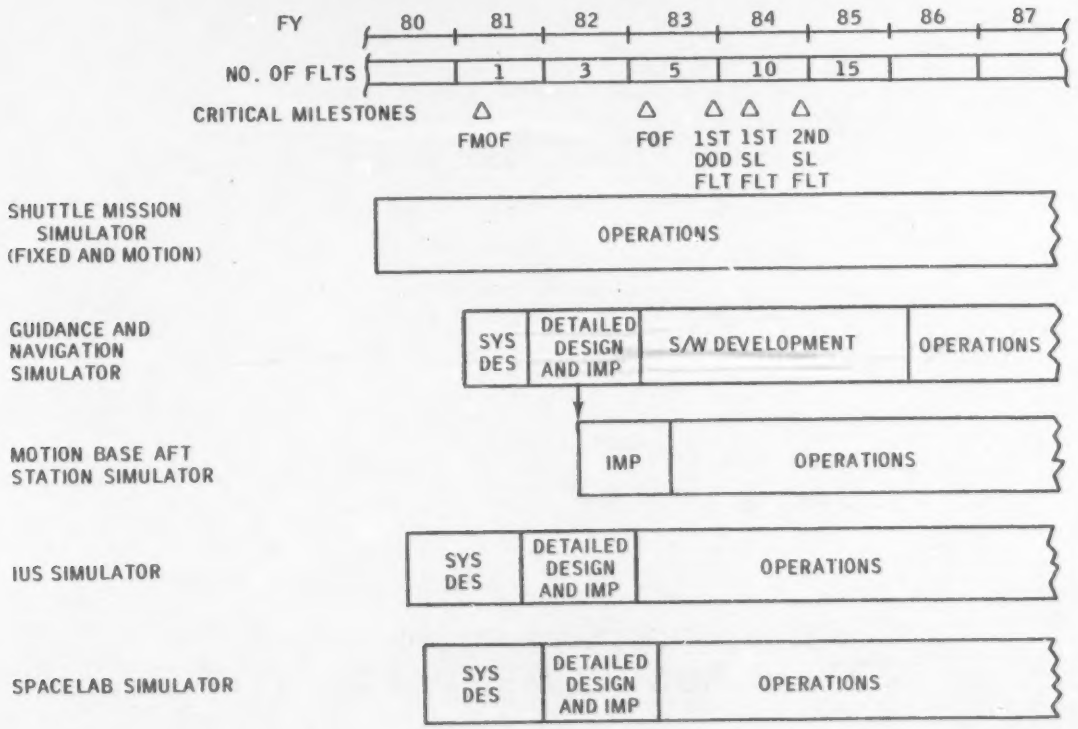
NASA-S-82-10196

OPERATIONAL FACILITIES IMPLEMENTATION STATUS



NASA-S-82-10195

OPERATIONAL FACILITIES IMPLEMENTATION STATUS CONCLUDED



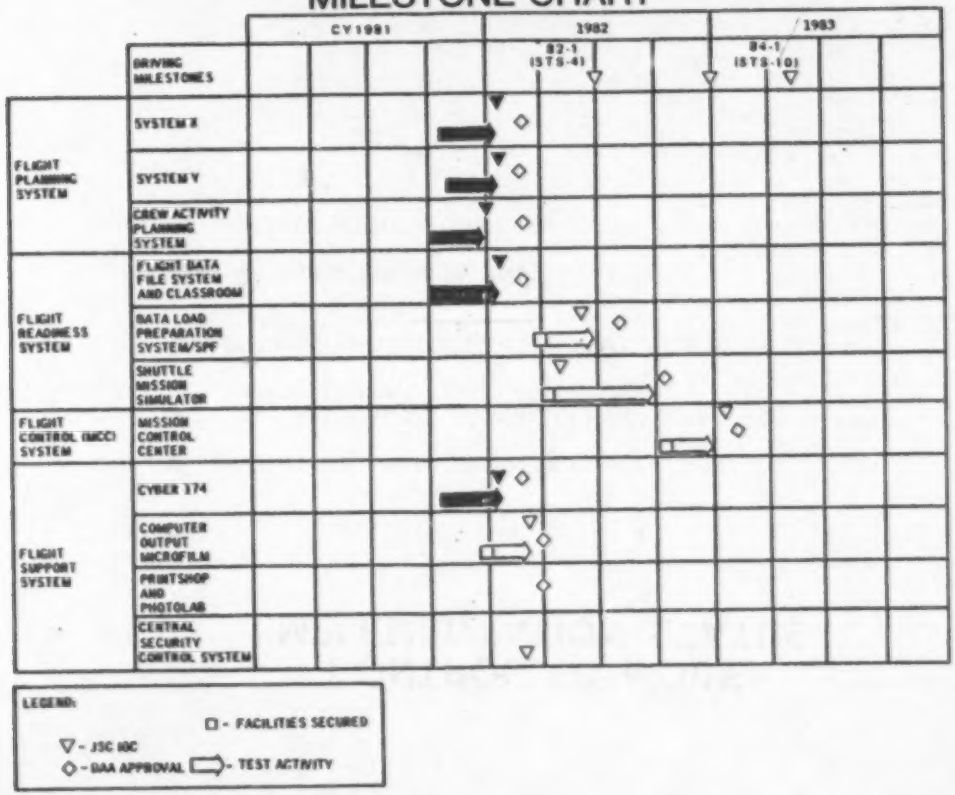
NASA-S-82-10185

OVERVIEW OF CONTROLLED MODE IMPLEMENTATION

- FLIGHT DESIGN
  - DEDICATED FLIGHT DESIGN SYSTEM AND CREW ACTIVITY PLANNING SYSTEM IN BUILDING 30
  - SHARED UNIVAC 1100 COMPUTER IN BUILDING 12 FOR DETAILED FLIGHT DESIGN
  - SHARED CYBER 174 COMPUTER IN BUILDING 30 FOR DATA MANAGEMENT SUPPORT
- SHUTTLE MISSION SIMULATOR (BUILDING 5)
  - SEPARATE CREW STATION COMPUTERS TO ALLOW DEDICATABLE STRING
  - MODIFIED VISITOR ENTRANCE AND VIEWING AREA SECURE COMMUNICATION BETWEEN BUILDING 5 AND 30
- MISSION CONTROL CENTER (BUILDING 30)
  - SECURE 1ST FLOOR COMPUTER/EQUIPMENT AREA
  - SECURE 3RD FLOOR CONTROL ROOMS AND PLANNING AREAS
  - PROVIDE DEDICATABLE STRING FOR FLIGHT SUPPORT

NASA-S-80-2387B

JSC CONTROLLED MODE DEVELOPMENT MILESTONE CHART



NASA-S-82-10184

CONTROLLED MODE IMPLEMENTATION STATUS

- ALL FACILITIES MODS COMPLETED JANUARY 1982
- FLIGHT PLANNING AND DATA REDUCTION ELEMENTS COMPLETE AND READY FOR INTERIM DOD APPROVAL
- REMAINDER OF SYSTEMS WILL BE COMPLETED BY DECEMBER 1982
- FINAL DOD APPROVAL BY MARCH 1983

SCHEDULE SUPPORTS FIRST LAUNCH CAPABILITY BY JULY 1983

Dr. KRAFT. OK. Joe.

Mr. LOFTUS. (Viewgraph C.) I would like to talk about our advanced missions studies. This discussion will be something of a change of pace from things that are going to happen on a schedule of days or months. These are things that happen on a schedule of years or decades.

(Viewgraph C-1 and -2.) We have spent most of our time this morning talking about the Shuttle which gives us basic asccess to low orbit for delivery, sortie and recovery missions, a very significant kind of new capability. But in advanced missions studies we have been thinking about the Shuttle as one element in a total space operations system. Transportation from Earth to orbit is by the Shuttle, then in low Earth orbit we envision that there are platforms or large serviceable spacecraft to which you attach payloads and what we here at the Johnson Space Center have called a space operations center, a space station, but one which is primarily needed by the transportation system as opposed to being needed by the payloads.

It's interesting to note that over 70 percent of the tonnage we take to low Earth orbit is propellant. It gives you some idea of the significance of the transportation needs beyond low Earth orbit. I think its significant that we have begun to understand that a space station is perhaps needed more for the transportation system than it is needed by payload functions.

An interesting way of thinking about problems is to think about who your competition is. If the space station is a laboratory, it competes with payloads, but if it's an operations facility, it's competing with launch vehicles. So in a sense, if the space station is a transportation device, what it is, is a way to eliminate the need for ever larger launch vehicles as payloads grow. The cargo bay becomes the definition of module size and we do assembly on orbit and we don't keep needing larger and larger launch vehicles, each with a low rate of use.

At the same time a space station does do things for certain specific payloads. The last element of a space operation system is something to get to the high energy orbits. There's a great virtue in using a cryogenic stage for that purpose. We think that the proper upper stage is a reusable aerobreaking cryogenic orbit transfer vheicle.

This slide illustrates the generic activities in space. The significant point is that if we have really good facilities in low Earth orbit they provide a 20- to 30-percent improvement in the capability of a given orbiter fleet. We can transfer launch window problems from the launch pad with its potential weather problems to a space-based facility and launch from there. Spare spacecraft can be stored to launch to operational positions when needed. Spacecraft too large or too heavy to lift with its upper stage can be mated to the stage on orbit.

Similarly a lot of the loiter time that's used when we carry multiple payloads is a burden that can be transferred to such a facility. It is significant to emphasize this relationship between a space station and the determination of fleet size. A proper space station complements the shuttle.

(Viewgraph C–3.) That, I think, is the point that one can make when one looks at the schedule of orbiter production; you've already recognized, that the decision to not proceed with 105 is perhaps the most significant decision one can take in the next year.

One aspect of the decision is that when you designate 104 or 105 as the last orbiter it sets a flag. It says there will have to be a replacement program. These vehicles will wear out. They will become economically not viable in 20 to 25 years based upon our experience. And this window between current production and a replacement fleet is an important window in two regards. One, when we complete the capital investments for the Shuttle, there is the opportunity to make other capital investments, but more importantly, what we do in this era will become the design environment for the replacement of this generation of the STS as well as the determinate of how many of these we will in fact need.

(Viewgraph C–4.) I'd like to talk just briefly to the orbiter as a space station. In a sense, we have a capability to maneuver and loiter on orbit with the existing orbiter, but mission duration is limited to 7 days.

(Viewgraph C–5.) If we add to that orbiter a solar array, and I might add this is the same solar array system we would use for a space station duration if extended.

(Viewgraph C–6.) With a solar array, the mission duration is a function of how much cryogen we carry and what orbit we go to. The basic orbiter has, for power to the payload, above the 14 kilowatts to power the orbiter, 7 kilowatts in roughly a 7-day mission capability. If we add the solar array then we have about a 20-day capability and 11 kilowatts to the payload in low Earth orbit at 28 degrees. At 55 degrees inclination we get out to about 22 days. If we go out of Vandenburg, we can go for almost 40 days duration.

If one really wanted to make the orbiter a zero order space station one could put 6 cryotanks in the cargo bay which would give a total of 10 cryogenic tank sets, and 22 days without the solar array, but with the solar array one can now consider 50- to 60-day missions out of ETR and 100-day missions out of WTR.

The real question about using the orbiter in such a space station manner is the opportunity cost in tying down transportation capability. It does give us a way to get long duration early.

(Viewgraph C–7.) We have been studying what we have called a space operations center. We've talked about what one could do with the orbiter as a zero order type of space station. Now we will talk to you about a phased development of a space operations center.

(Viewgraph C–8.) It's important to understand what is needed in terms of a fully space-based capability if we are to evolve in an efficient manner. We have explored what it means if a space station is for on-orbit assembly. It provides a staging capability such that one can have manned geosynchronous access. It assures the United States dominance of a critical region. It gives the United States permanent capability and it is efficient in use of the STS.

(Viewgraph C–9.) This is what we envision the basic facility to be, redundant command and operations modules, an energy section which has the solar arrays, the energy power generation and distribution, two habitation units, a transfer tunnel, a stage assembly fa-

cility, propellant storage tank and a hanger for operations on upper stages.

The propellant storage tank is significant because we believe we can transfer substantial amounts of propellant to orbit and improve the load factor of the orbiter by scavenging the flight performance reserves out of the ET, in effect, bootstrapping the propellant to orbit, and such propellant is most of what we take into orbit. That's a significant savings because most of the energy to lift it to orbit has already been spent.

(Viewgraph C–10.) Let me speak briefly then to how we would evolve a space station which becomes feasible only if you know where you want to go. We do have to recognize budget and schedule constraints. There's a certain inherent modularity because things have to go to orbit in the orbiter cargo bay, and we want to design the program to match the demands.

(Viewgraph C–11.) We believe we can do this in three phases, and the key to each later phase is the first phase because the sizing of that energy system has to be based upon the ultimate capability one wants and the modularity which one uses is then a function of the units of development.

(Viewgraphs C–12 and 13.) We would envision three phases. In the first phase, we would have two deliveries. The first of the command modules and the energy section, a stage assembly fixture, and a logistics module. This would provide an initial level of capability, but it would not have the level of redundancy with which one would feel comfortable in having it permanently manned.

There is a strategy that one could use if it was desirable to have early manning. That is, you could add a redundant unit which in effect, is a storm cellar, and put a constraint on orbiter operations such that one can launch to rescue within 2 weeks.

(Viewgraph C–14.) In phase 2, however, you would certainly have, with the second command module in place, a level of redundancy with which you would feel comfortable in going to permanent manning.

At this time also we could do a significant amount of basing and staging and have some commercial payloads on board such as the continuous flow electrophoresis units—or others.

(Viewgraph C–15.) In the third phase we would have the full core capability and the program could be done on whatever schedule budgets made reasonable. The most significant increment of commitment is phase 1, we've estimated that to be about a $4 billion commitment.

(Viewgraph C–16.) In order to put the SOC in some perspective it's interesting to contrast it with the Shuttle itself. The orbiter has 66 cubic meters in the crew compartment, with the Spacelab it has 138 cubic meters. Salyut 6 for comparison is 90 cubit meters. SOC we envision to be about 209 cubic meters of pressurized volume.

It is noteworthy that SOC is a significantly simpler spacecraft than the orbiter, because it does not have to accommodate atmospheric flight in launch or re-entry, so it is in fact a relatively simple spacecraft.

(Viewgraph C–17.) As a consequence, we estimate that it is about a third the value of the Shuttle program. The Shuttle D.D.T. & E. program as a whole in constant 1982 dollars is about $21 billion. It

was, of course, in real year dollars only $10 billion. Comparing the all-up SOCC and the orbiter you can see a relationship of $8 to $14 billion.

(Viewgraph C–18.) Another interesting way of looking at the value of a space station is to contrast the cost of spacecraft. The Apollo Command and service module [CSM] was of course a planetary type spacecraft and compares favorably with other high energy spacecraft in terms of cost per pound.

You may recall in the early 1970's we did two very large and elaborate space station studies, $10 million each. Our estimate of the cost per pound of spacecraft such as a space station at that time was $100,000 per pound. We actually brought the orbiter in at $40,000 per pound. We're currently estimating an all-up full capability SOC at a total cost of $8½ billion. This would be, on a dollars-per-pound basis, not very much different than other low Earth spacecraft, approximately $30,000 per pound. I wouldn't attach too much significant to that estimate except I think it does reflect a maturity in the industry that we can bring our costs down.

(Viewgraph C–19.) There are three things in terms of technology that we think are very critical to a space station and its future. One of these we have called satellite services and we believe that this begins with the orbiter. We talk about the deployment, the inspection, the retrieval, the servicing or support activities that we would perform for spacecraft such as the Solar maximum or to a platform and then, of course, recovery and return to Earth.

It is interesting to note that those are the same services one would expect to perform from a space station. So we are in fact beginning to learn and to develop that capability in the routine operations of the orbiter itself.

(Viewgraph C–20.) There are two other technologies that are very critical to a successful space station. One of them is a regenerable life support system because the life support system can be such a driver on the total logistics if you cannot close these loops. We believe the electrochemistry is at hand to do regenerable life support systems. We, and the Ames Research Center have in fact got at least one if not two prototype devices for each of these functions. We have the units in test here at JSC and will be prepared to do integrated testing in the next year. We would need only to take food and hydrazine up to such a facility because we close the water loops and the gas loops and thereby save very substantial amounts in terms of the logistics.

(Viewgraph C–21.) We believe that this technology is at hand. The other aspect of technology that's significant to a large device such as the space station is the power generation distribution and the rejection of the waste heat. We've made substantial progress in the development of large area solar cells which redce the cost of arrays by about 15 percent. We understand the interaction between larger arrays at high voltages and the environments that exist in a low Earth orbit.

We've done a great deal of work in fuel cells. We've also been doing work in electrolysis cells which look to be very attractive as energy storage mechanisms because the high operating temperatures of fuel cells and electrolysis cells allow efficient rejection of the waste heat.

We have developed space maintainable radiators using heat pipe technologies and thermal buses which allow addition and removal of heat loads. We have in work an 8 p.s.i. EVA suit to substantially reduce the amount of crew pre-EVA breathing and the overhead to allow EVA. One of the virtures in having a hydrogen-oxygen system is that it helps you in terms of the OTV and its propellant requirements.

(Viewrgraph C–22.) The last item I'd like to speak very briefly to is the orbiter experiments program [OEX]. As you're well aware, OAST (Office of Aeronautics and Space Technology) is the part of the agency working on this project, but JSC does the integration activity. This program in effect, allows us to use the orbiter as we would one of the X series experimental aircraft to advance our knowledge in aeronautics.

(Viewgraph C–23.) The next slide shows briefly some of those experiments. The temperature sensing of lee side or top temperatures with the IR scanner, that is yet to be installed. We have a flight dynamics package, and an air data system.

(Viewgraph C–24.) All of the experiments are listed here. I think this list simply makes the point that Chris made in his introductory remarks that aeronautics and space have a synergism; that we learn much out of the orbiter that will be applicable to our high performance aircraft of the future. This is a valuable use of the shuttle in support of that aeronautics program. That's all I have to say.

[Viewgraphs C through C–24 of Mr. Loftus' oral presentation follow:]

NASA-S-82-10200

ADVANCED PROGRAMS

762

J. P. LOFTUS
FEBRUARY 15, 1982

98-418 O—82—49

NASA SOC
5-82-00043

Elements Of A Space Operations System

- EARTH TO LOW ORBIT
  - BASIC ACCESS TO SPACE SHUTTLE
    - DELIVERY
    - SORTIE
    - RECOVERY
- LOW EARTH ORBIT
  - PLATFORMS FOR EXTENDED OBSERVATION · MANUFACTURING
  - SPACE OPERATIONS CENTER
    - TRANSPORTATION
      - STAGE TO PAYLOAD ASSEMBLY
      - LAUNCH WINDOW LOITER
      - UPPER STAGE SERVICING
      - SPARE SPACECRAFT STORAGE
      - TEND CO-ORBITING SPACECRAFT
    - PAYLOAD
      - LARGE SPACE STRUCTURE ASSEMBLY
      - MANNED LIFE SCIENCES
      - SCIENCE AND APPLICATIONS
- HIGH ENERGY ORBITS
  - STAGED FROM SOC
  - AEROBRAKING RETURN TO SOC

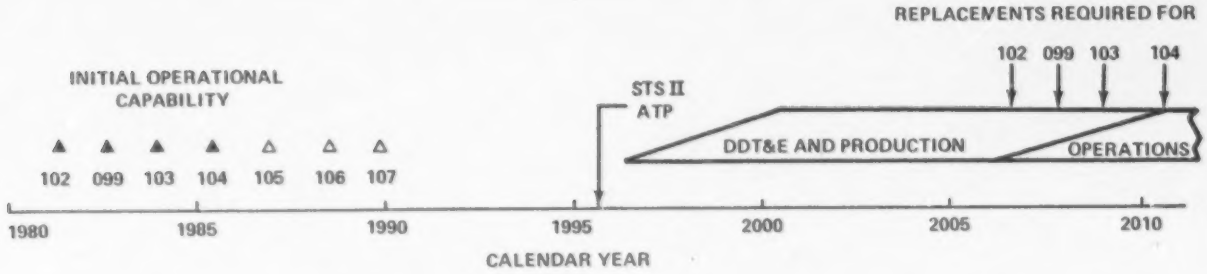
Future Of Space Flight

- LEO
  - APPLICATIONS
    - SCIENCE — NASA BUDGET CONSTRAINED
    - APPLICATIONS — GOVERNMENT R&D BUDGET CONSTRAINED
      COMMERCIAL INTEREST DEMAND DRIVEN
      (MFR IN SPACE)
  - MILITARY — SURVEILLANCE
- GEO
  - APPLICATIONS — MAXIMUM – INDETERMINATE
  - SCIENCE — MINIMAL
  - MILITARY — COMM/SURVEILLANCE
    EQUAL INTEREST 1/2 AND 2 X GEO PERIODS
- ESCAPE
  - PLANETARY EXPLORATION
- WELL CONCEIVED FACILITIES HAVE MULTIPLIER EFFECT ON TRANSPORTATION EFFICIENCY
- E.G., LEO – UNMANNED SCIENCE/APPLICATION PLATFORM (28°)
  - SPACE OPERATIONS CENTER (28°)
  - UNMANNED SCIENCE/APPLICATION PLATFORM (98°/0930)
    ∿ 1.2 -.3 X CAPABILITY
    LOAD FACTOR
    LAUNCH CONSTRAINTS

NASA SOC

S-82-00045

The Significance of Orbiter Production


REPLACEMENTS REQUIRED FOR
102 099 103 104
INITIAL OPERATIONAL CAPABILITY
STS II ATP
DDT&E AND PRODUCTION
OPERATIONS
▲ ▲ ▲ ▲ △ △ △
102 099 103 104 105 106 107
1980 1985 1990 1995 2000 2005 2010
CALENDAR YEAR

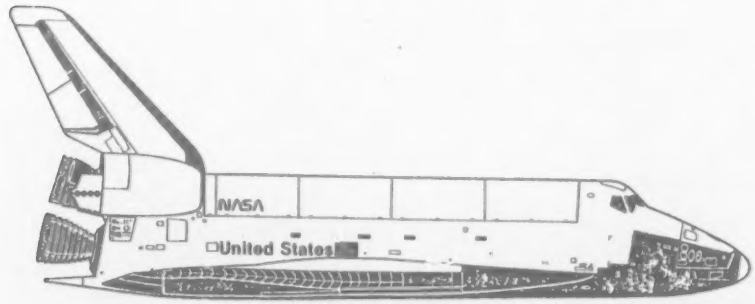
- ORBITER ECONOMIC LIFE IS ABOUT 25 YEARS
- DDT&E AND PRODUCTION FOR REPLACEMENT VEHICLE IS ABOUT 10 YEARS
- PROPER FLEET SIZE EXTENDS PRODUCTIVE LIFE OF INDIVIDUAL ORBITERS THEREBY DEFERRING NEED FOR STS II
- STOPPING ORBITER PRODUCTION ESTABLISHES SCHEDULE FOR REPLACEMENT VEHICLE

NASA-S-82-10166

STS/ORBITER
A ZERO ORDER SPACE STATION

ORBITER CAPABILITIES:

ELECTRICAL POWER - 7 KW TO PAYLOAD
DURATION - 7 DAYS
HEAT REJECTION - 8.5 KW TO PAYLOAD (FAVORABLE ENVIRONMENT FOR RADIATORS)



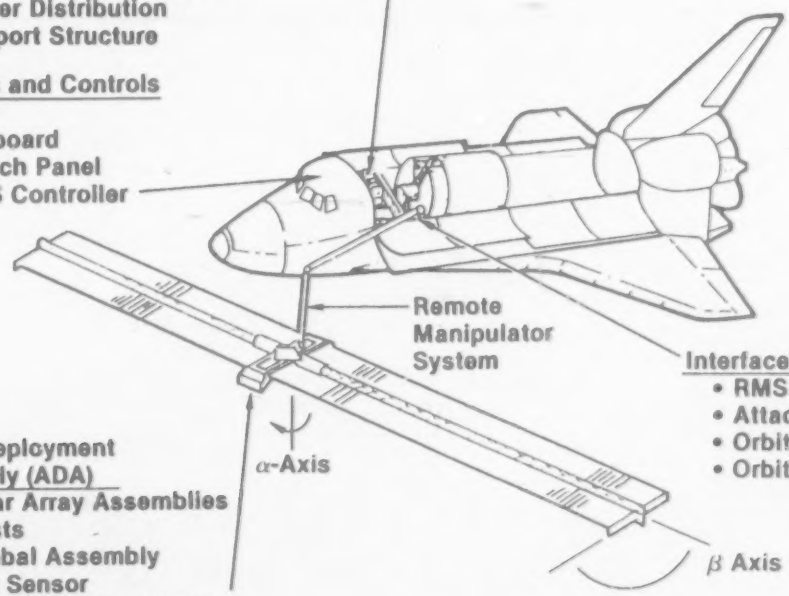
NASA-S-80-1819A

POWER EXTENSION PACKAGE

Elements

Power Regulation/Control Assembly (PRCA)
- Regulators, Cold Plates
- Power Distribution
- Support Structure

Displays and Controls
- CRT
- Keyboard
- Switch Panel
- RMS Controller

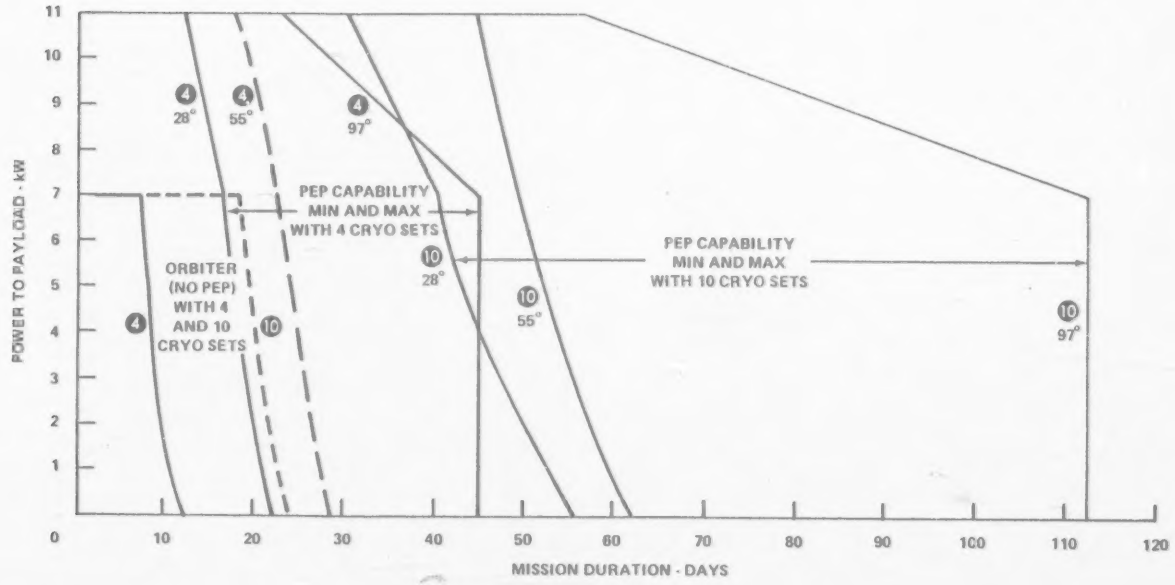


Interface Kit
- RMS Power Cable
- Attachment Fittings
- Orbiter Bay Piping
- Orbiter Bay Wiring

Array Deployment Assembly (ADA)
- Solar Array Assemblies
- Masts
- Gimbal Assembly
- Sun Sensor
- Instrumentation/Controls

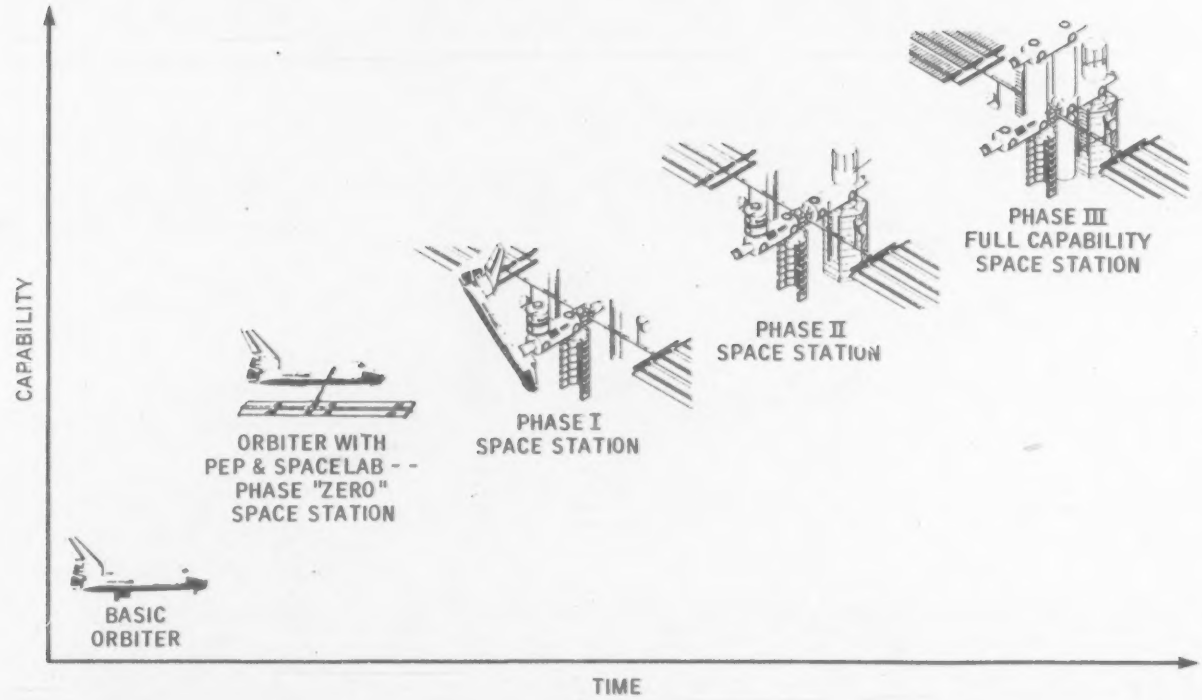
NASA-S-82-10293

PEP PERFORMANCE ENVELOPE
220 N.M. 28°→97° INCLINATION


POWER TO PAYLOAD - kW
MISSION DURATION - DAYS
4 28°
4 55°
4 97°
PEP CAPABILITY MIN AND MAX WITH 4 CRYO SETS
ORBITER (NO PEP) WITH 4 AND 10 CRYO SETS
10 28°
10 55°
PEP CAPABILITY MIN AND MAX WITH 10 CRYO SETS
10 97°

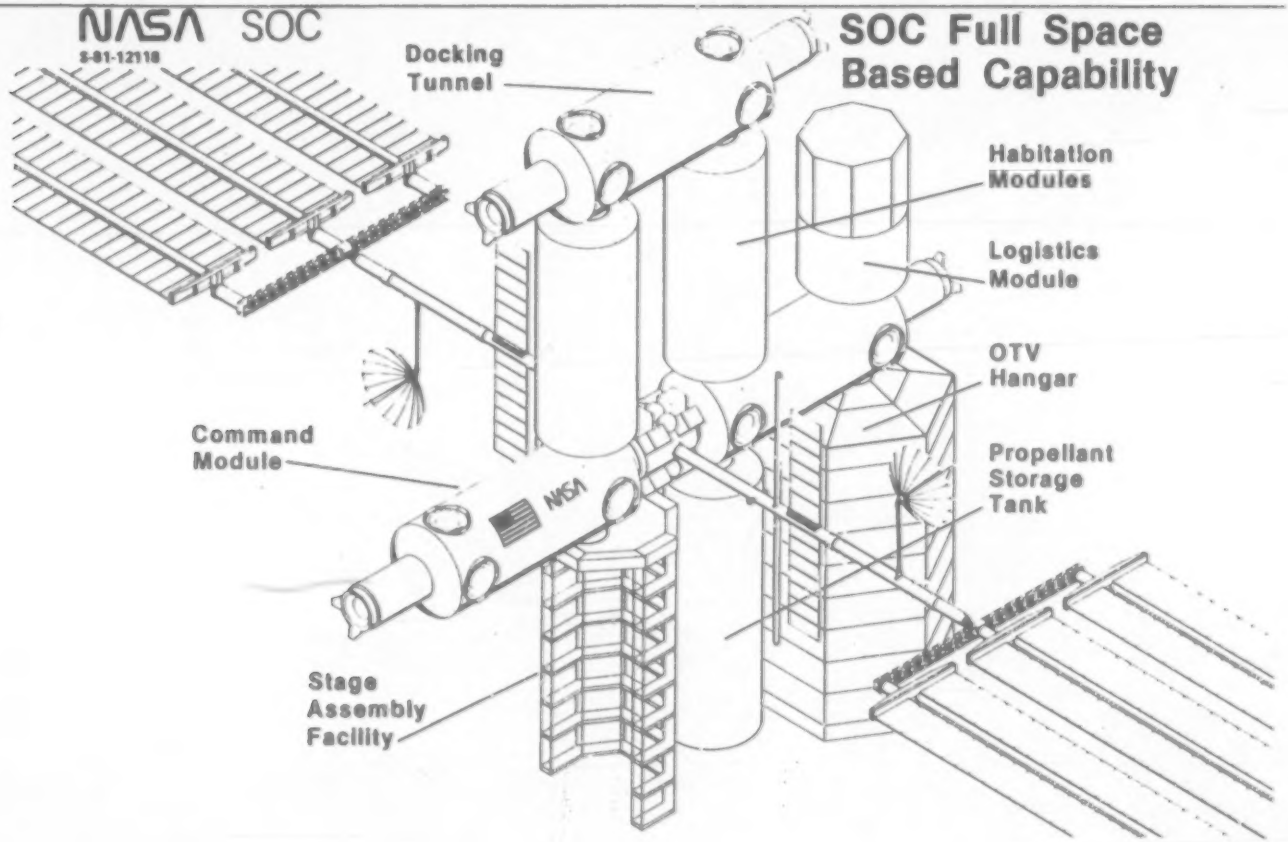
NASA-S-82-10165

BUILDING BLOCKS TO SPACE OPERATIONS


CAPABILITY
TIME
BASIC ORBITER
ORBITER WITH PEP & SPACELAB - - PHASE "ZERO" SPACE STATION
PHASE I SPACE STATION
PHASE II SPACE STATION
PHASE III FULL CAPABILITY SPACE STATION

FULL SPACE-BASED CAPABILITY

- ON-ORBIT ASSEMBLY, LAUNCH, RECOVERY, AND SERVICING OF SPACE VEHICLES.
- PROVIDES FOR MANNED ACCESS TO GEOSYNCHRONOUS AND OTHER SIGNIFICANT ORBITS.
- ASSURES U.S. STRATEGIC AND TECHNICAL DOMINANCE IN THE SPACE COMMERCIAL AND MILITARY AREA THROUGH THE BALANCE OF THE CENTURY.
- PERMANENT MANNED OPERATIONS CAPABILITY IN SPACE WITH REDUCED DEPENDENCE ON EARTH FOR CONTROL.
- EFFICIENT USE OF THE SHUTTLE AS AN EARTH-TO-ORBIT TRANSPORTATION SYSTEM.


NASA SOC
S-81-12118
SOC Full Space Based Capability
Docking Tunnel
Habitation Modules
Logistics Module
OTV Hangar
Propellant Storage Tank
Command Module
NASA
Stage Assembly Facility

NASA-S-82-10174

PROGRAM APPROACH

- EMPHASIZE INCREMENTAL GROWTH OF CAPABILITY FOR FLEXIBILITY IN ACCOMMODATING BUDGET AND SCHEDULE CONSTRAINTS.
- PROVIDE MODULARITY IN BOTH STRUCTURE AND SUBSYSTEMS.
- DESIGN PROGRAM INCREMENTS TO MATCH DEMAND FOR MAGNITUDE AND TYPE OF SPACE-BASED SERVICES.
- EACH PROGRAM PHASE ESTABLISHES SIGNIFICANT INCREASE IN U.S. MANNED SPACE CAPABILITY AND CAN BE JUSTIFIED AS A STAND-ALONE PROGRAM IF NECESSARY.
- INHERENTLY THE MODULE IS LESS THAN CARGO BAY DIMENSION.

NASA-S-82-10178

INITIAL CAPABILITY

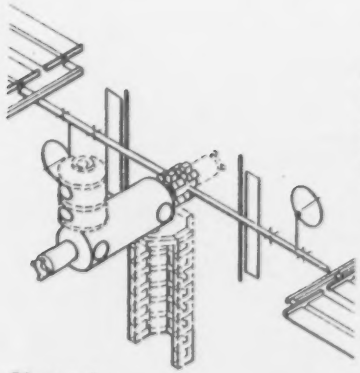
- PROVIDES MANNED SPACE STATION CAPABILITY SUPERIOR TO SOVIETS
- PERMITS SPACE BASING AND ASSEMBLY OF PAYLOADS AND UPPER STAGES
- ACCOMMODATES EARLY LONG-DURATION COMMERCIAL TEST AND PROTOTYPE PLANTS
- ACCOMMODATES ALL MANNED SPACE AND LIFE SCIENCE REQUIREMENTS
- ESTABLISHES BASIS FOR MODULAR GROWTH TO FULL SPACE-BASED OPERATIONS CAPABILITY

NASA SOC

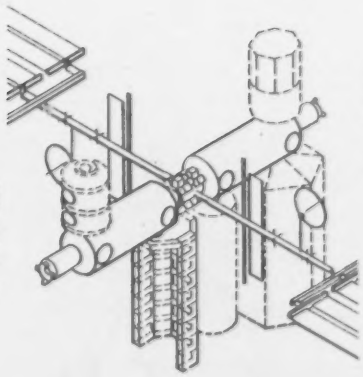
S-81-11894 A

Phased Capability

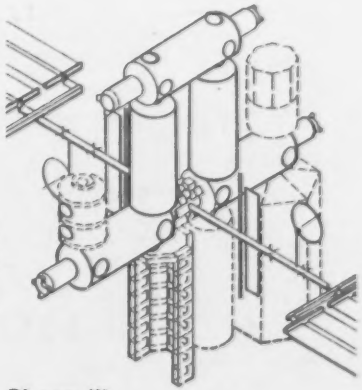
Phase I, II, III



Phase I



Phase II



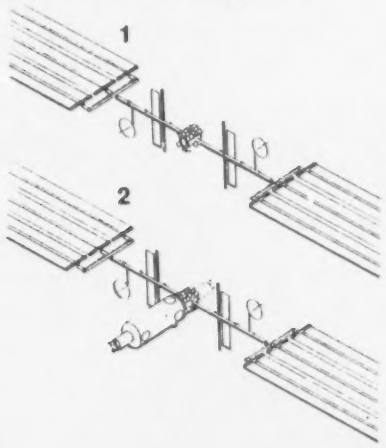
Phase III

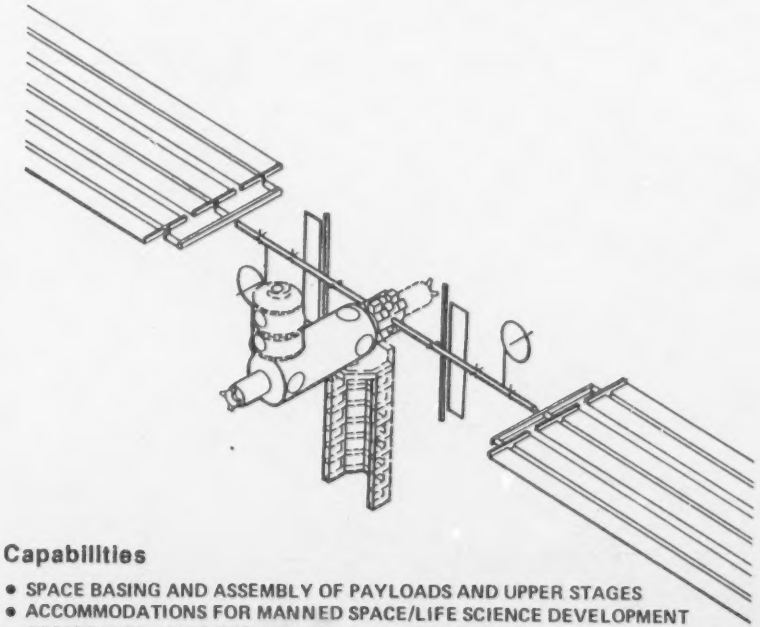
NASA SOC

S-81-11896A

Phased Capability
Phase I

Core assembly sequence





Capabilities

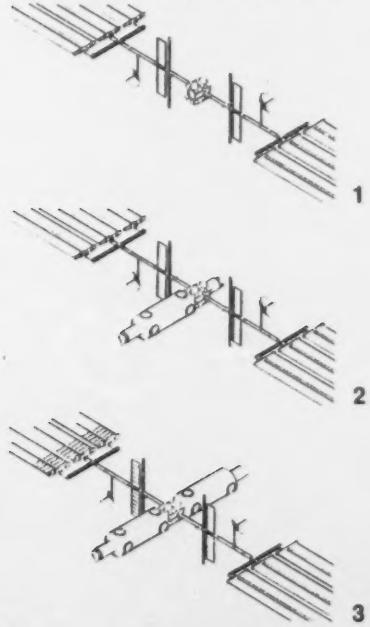
- SPACE BASING AND ASSEMBLY OF PAYLOADS AND UPPER STAGES
- ACCOMMODATIONS FOR MANNED SPACE/LIFE SCIENCE DEVELOPMENT
- PERIODIC OR LONG TERM MANNED ATTENDANCE
- PROVIDES FOR DEVELOPMENT OF OPERATIONS TECHNIQUES AND EQUIPMENT

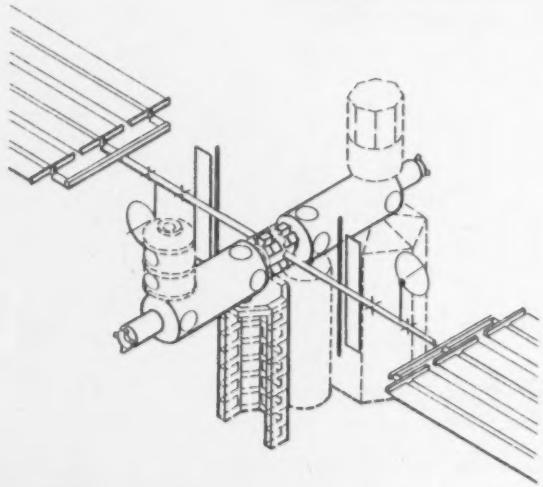
NASA SOC

S-81-11895A

Phased Capability
Phase II

Core Assembly Sequence





Capabilities

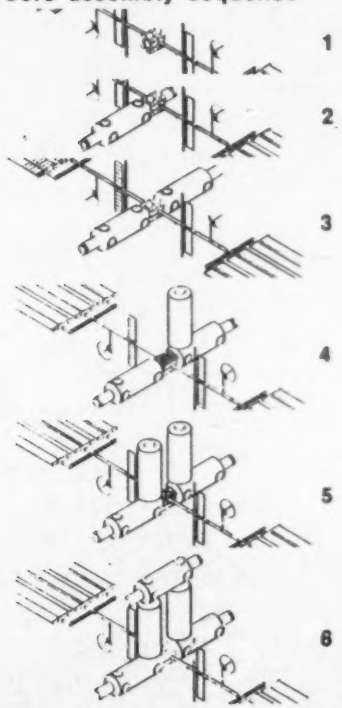
- CONTINUOUS MANNED ATTENDANCE
- ROUTINE ACCESS TO GEOSYNCHRONOUS ORBIT WITH SPACE BASED PROPELLANT STORAGE
- ROUTINE SATELITE SERVICING
- INITIAL COMMERCIAL SPACE/LIFE SCIENCE LARGE QUANTITY PRODUCTS

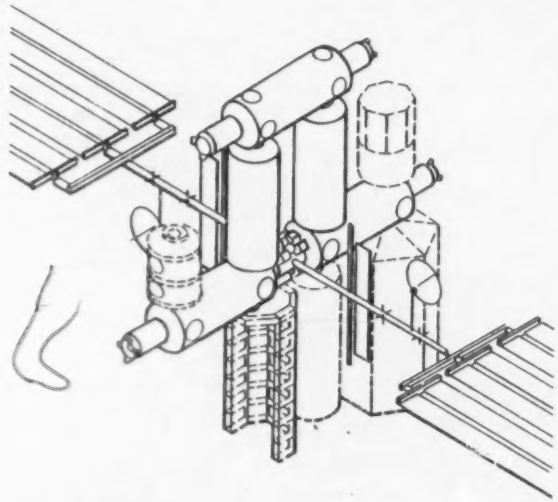
NASA SOC

S-81-11897A

Phased Capability
Phase III

Core assembly sequence





Capabilities

- LARGE CREW–CONTINOUS MANNING
- ROUTINE ACCESS TO GEO AND OTHER STRATEGIC/COMMERCIAL ORBITS
- ACCOMMODATES DOD REQUIREMENTS
- ACCOMMODATES LARGER COMMERCIAL/INDUSTRIAL FACILITIES

NASA SOC

S-82-00059

Comparison of Space Shuttle Orbiter and the Space Operations Center

Space Operations Center

245,731 lbs dryweight

209 m^3 pressurized volume

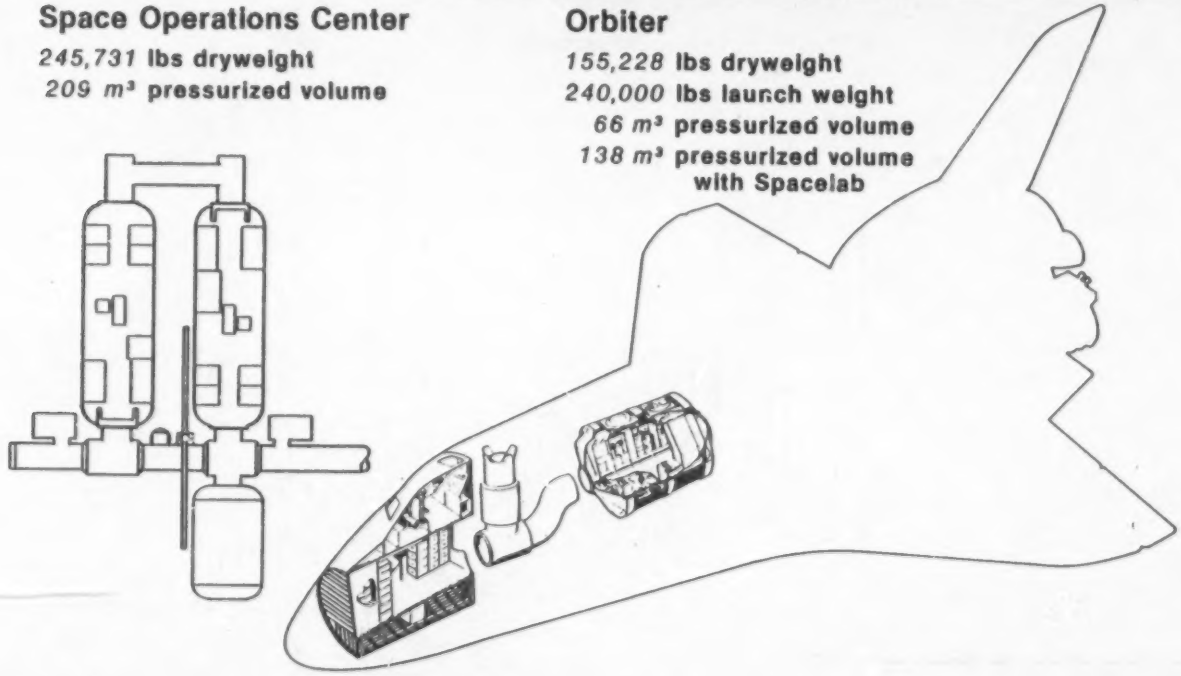
Orbiter

155,228 lbs dryweight

240,000 lbs launch weight

66 m^3 pressurized volume

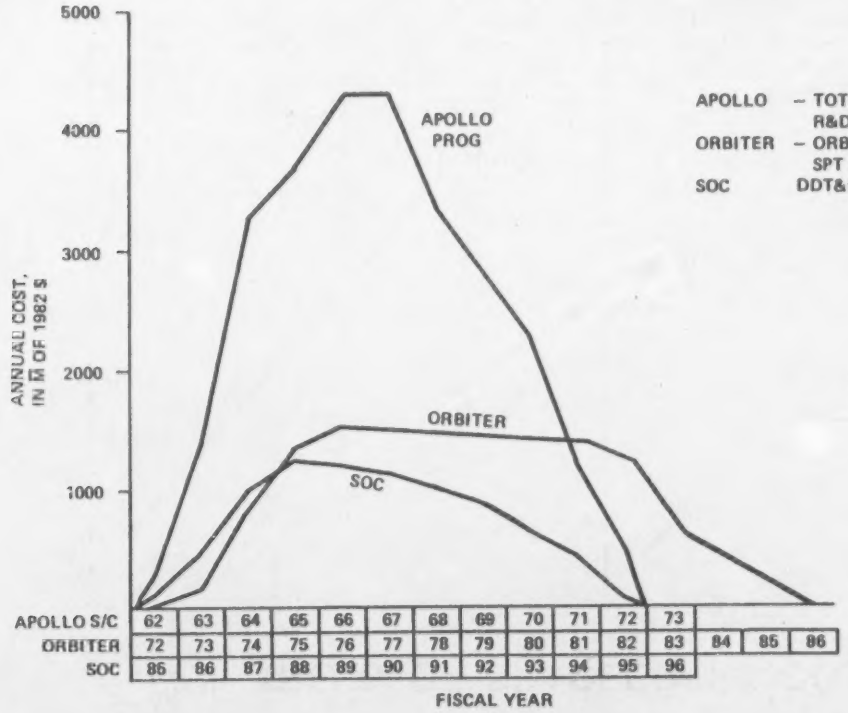
138 m^3 pressurized volume with Spacelab



NASA SOC

S-82-00066 A

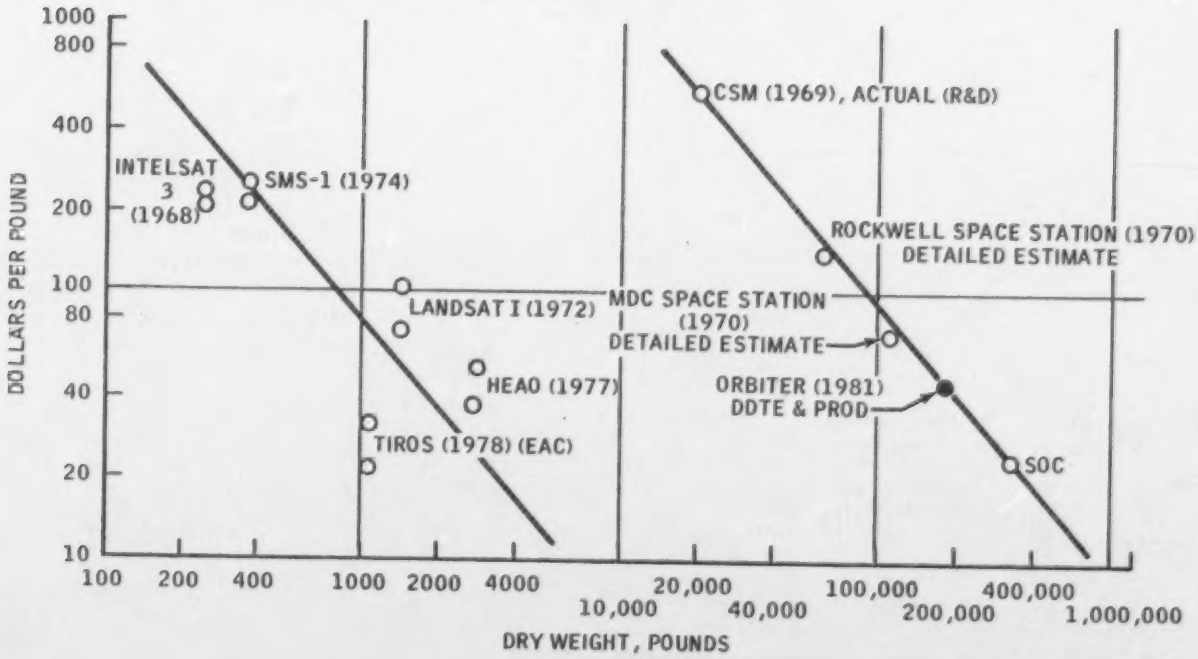
Program Cost Comparison



		82 $	(RY $)
APOLLO	– TOTAL APOLLO R&D PROGRAM	67,600	(12,500)
ORBITER	– ORBITER + PROG SPT (DDT&E + PROD)	14,000	(10,200)
SOC	DDT&E + PROD	8,500	(17,200)

NASA-S-82-10177

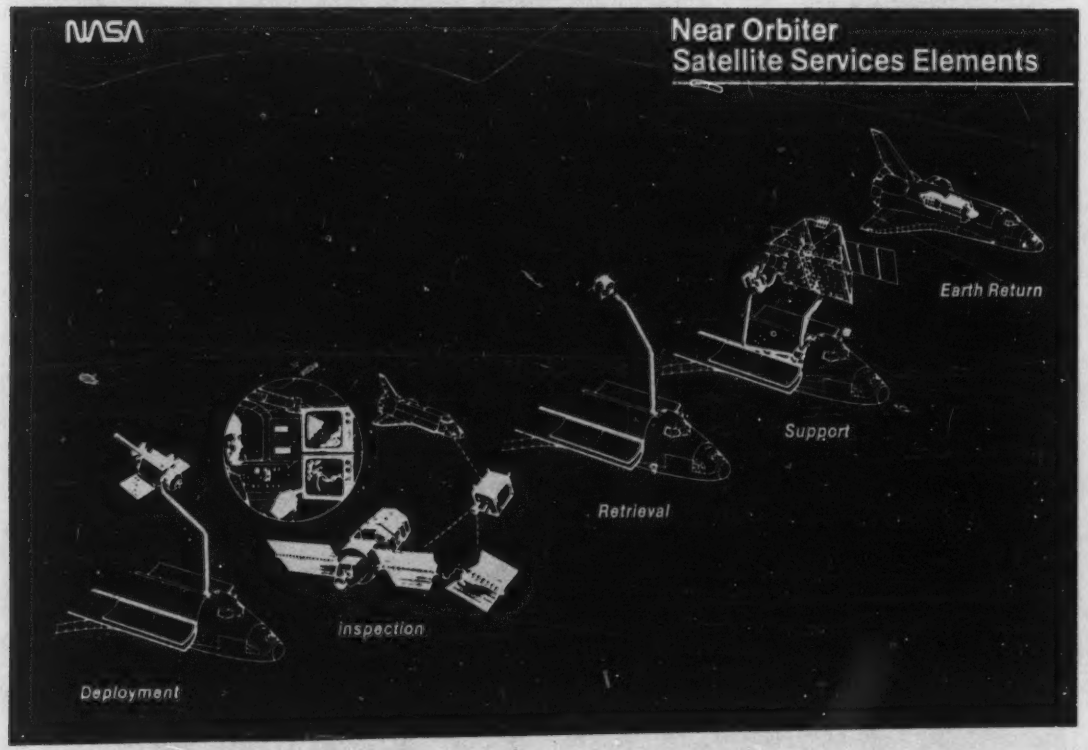
TREND OF SPACECRAFT COSTS



NASA National Aeronautics and Space Administration

S-79-10092

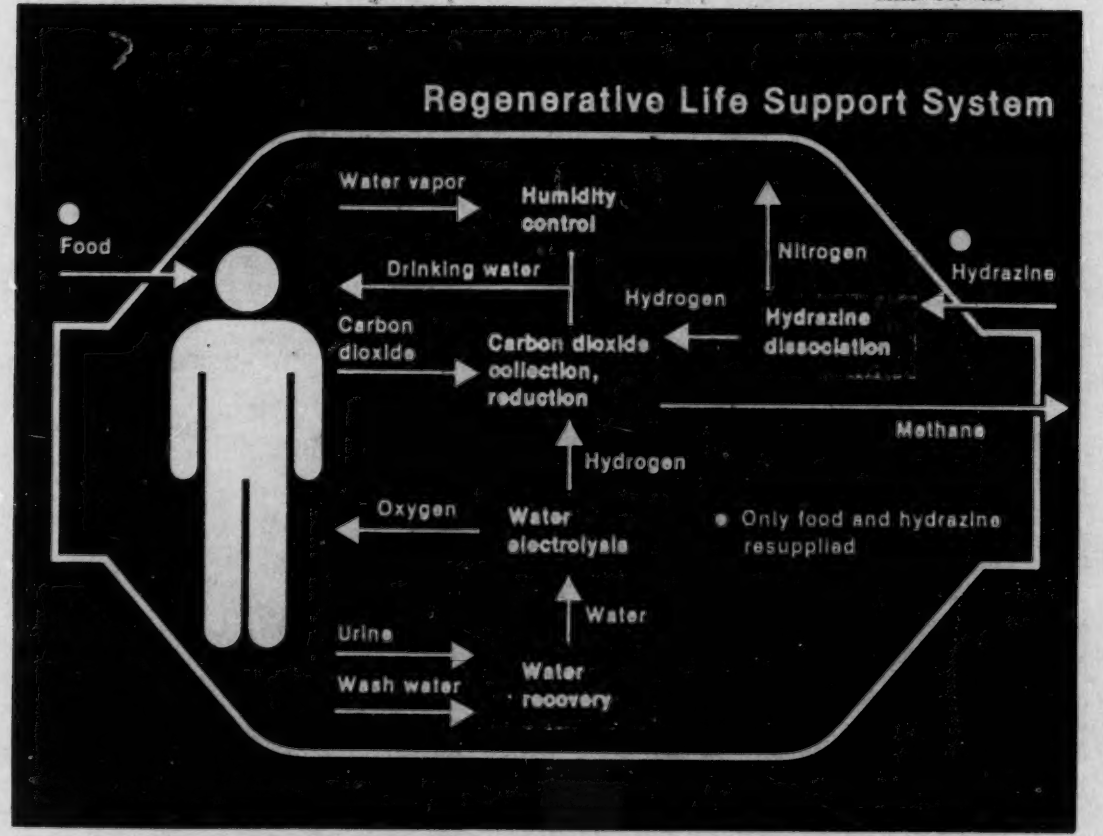
Lyndon B. Johnson Space Center
Houston Texas 77058



NASA National Aeronautics and Space Administration

S-79-10146

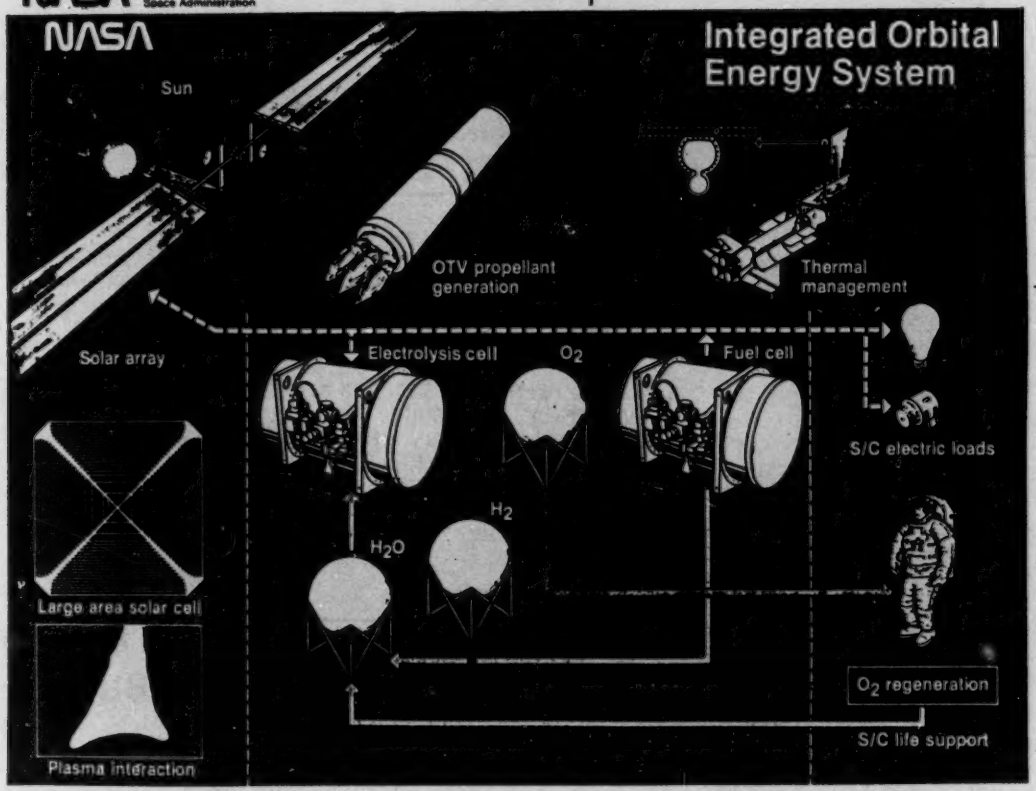
Lyndon B. Johnson Space Center
Houston, Texas 77058



NASA National Aeronautics and Space Administration

S81-41619

Lyndon B. Johnson Space Center
Houston, Texas 77058

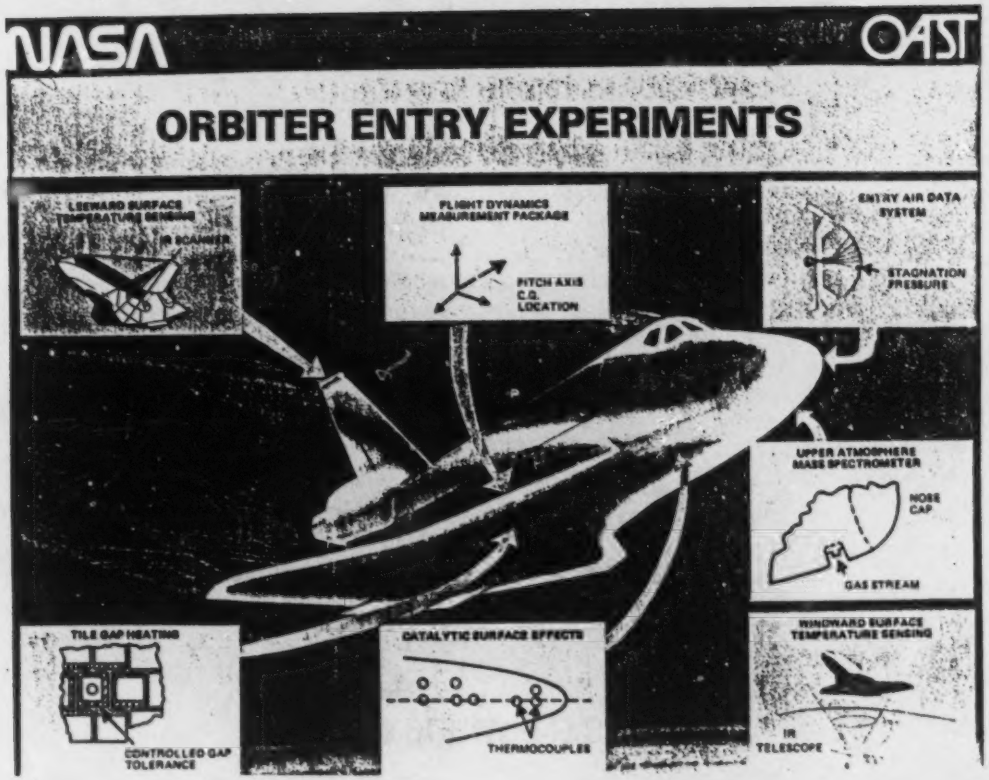


NASA-S-82-10199

ORBITER EXPERIMENTS PROGRAM OBJECTIVES AND JUSTIFICATION

- OBJECTIVES
  - AUGMENT R&T BASE FOR FUTURE VEHICLE DESIGN BY UTILIZING SHUTTLE AS A RESEARCH VEHICLE TO COLLECT DATA
  - MINIMIZE TOTAL VALUE OF GROUND-BASED FACILITY DATA BY COLLECTING FLIGHT DATA FOR
    - VERIFICATION AND CORRELATION WITH GROUND DATA
    - DEVELOPMENT OF PROCEDURES FOR EXTRAPOLATION OF GROUND FACILITY RESULTS TO FLIGHT CONDITIONS
- JUSTIFICATION
  - UNIQUE SPACE ENVIRONMENT REQUIRED
  - FLIGHT EXPERIMENT IS COST EFFECTIVE
  - IN-SPACE DEMONSTRATION ESSENTIAL TO ACCELERATE ACCEPTANCE OF ADVANCED TECHNOLOGY BY USER

S- 80- 26596


NASA
OAST
ORBITER ENTRY EXPERIMENTS
LEEWARD SURFACE TEMPERATURE SENSING
IR SCANNER
FLIGHT DYNAMICS MEASUREMENT PACKAGE
PITCH AXIS C.G. LOCATION
ENTRY AIR DATA SYSTEM
STAGNATION PRESSURE
UPPER ATMOSPHERE MASS SPECTROMETER
NOSE CAP
GAS STREAM
TILE GAP HEATING
CONTROLLED GAP TOLERANCE
CATALYTIC SURFACE EFFECTS
THERMOCOUPLES
WINDWARD SURFACE TEMPERATURE SENSING
IR TELESCOPE

Congressman FLIPPO. Could you comment on the level of funding for advanced programs over the last several years?

Mr. LOFTUS. It has declined very substantially in each year. It's had a very adverse effect. I think we need and could profitably use more funding.

Congressman FLIPPO. Do you think that's a program that ought to be level funded over the years instead of the up and down arrangement?

Mr. LOFTUS. Level funding I'm not sure would be fully profitable. I think it might be that one should recognize it ought to be countercyclical with some of the development programs. Also I think one needs to recognize the lead times that are required in technology activities. I don't think we've done that adequately.

Congressman FLIPPO. Thank you.

Dr. KRAFT. Ronnie, I think that we had a situation that developed in the Mercury-Gemini-Apollo-Skylab sequence that was probably not appreciated by the people external or even internal to NASA. That was that there was a development of technology, that was an ongoing part of each one of those programs. A certain amount of the funds from those programs went into an advancement in the state of technology upon which each one of the following programs could then depend. This kind of activity was curtailed in the Shuttle program because of the strong limits of the budgetary support during the 1970's.

We were unable to do backup development. In other words there was very little money of the Shuttle that went into technology upon which we could then build the next ship. Let me be more specific. In the late 1960's and early 1970's we were able to develop a new fuel cell. We were able to develop the thermal protection system and a base line for the very complicated avionics that went into the Shuttle. All three of these very important parts of technology were a base upon which we could build a Space Shuttle. We didn't have to wait for that system to get defined before we could make that next step. Now I think that where we're finding ourselves today is that without the investment that we had been able to make in the past and have been unable to make in the last decade there is a real need for a certain amount of technology development effort. It's bigger, therefore. At least one order of magnitude if not more in terms of advanced programs in order to have the right capability to make this next step.

That's an unfortunate set of circumstances and one that has got to be recognized when you start the space operations center or space station or whatever you choose to call it.

Congressman FLIPPO. Thank you. That seems to conclude the questions. We really did appreciate the presentation. Very helpful to us. It's always a pleasure to come to Houston. Thank you very much.

[Whereupon the subcommittee adjourned, subject to the call of the Chair.]

1983 NASA AUTHORIZATION

MONDAY, FEBRUARY 22, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:05 p.m., in room 2318, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Mr. FLIPPO. The subcommittee will come to order.

Today we continue our review of NASA's fiscal year 1983 budget with hearings on the Office of Space Science and Applications. We have a new Office and a new chief of that Office.

The new chief is Dr. Burton I. Edelson, Assistant Administrator, who came to NASA from COMSAT. We look forward to hearing Dr. Edelson's views on where the Office of Space Science and Applications should be going. That Office was formed late last year—as part of a NASA reorganization—by combining the Offices of Space Science and of Space and Terrestrial Applications.

The reorganization seems to have been made at the expense of Applications programs which have almost disappeared from the chart. When we also see the Applications budget taking a large cut, we become concerned and therefore want to look into this matter.

A second, equal concern, has to do with the fate of the planetary programs. Our country has benefited greatly from these activities in the past but the budget request is down $50 million this year. A NASA press release dated January 26, 1982, reporting on the Venus Science Conference held in Palo Alto describes "studies of Venus which provide a variety of insights into Earth mechanisms."

For example, a phenomenon called "wave pumping" seems to be critical to understanding atmospheric circulation on both planets, but the phenomenon itself is not well understood. By comparing circulations on Earth and Venus we may be able to improve our understanding of this phenomenon and eventually to improve our ability to predict terrestrial weather and climate.

Because it has the potential of helping us understand our own planet, Earth, we are concerned when we see the planetary program under threat, and we want to look into this as well.

[The opening statement of Hon. Harold C. Hollenbeck follows:]

OPENING STATEMENT FOR HON. HAROLD C. HOLLENBECK
NASA AUTHORIZATION HEARINGS
FEBRUARY 22, 1982

THANK YOU, MR. CHAIRMAN. I WELCOME YOU, DR. EDELSON, TO YOUR FIRST TESTIMONY BEFORE OUR SUBCOMMITTEE AS A NASA EMPLOYEE. MANY OF US PREVIOUSLY HEARD FROM YOU WHEN YOU WERE WITH COMSAT; YOUR DEDICATION AND EXPERTISE HELPED ELEVATE THE U.S. SPACE COMMUNICATIONS INDUSTRY TO ITS PRESENT DAY WORLDWIDE LEADERSHIP. WE ARE INDEED PLEASED TO SEE A MAN OF YOUR EXPERIENCE JOIN THE NASA WORK FORCE IN THE NEWLY FORMED OFFICE OF SPACE SCIENCE AND APPLICATIONS.

THIS OFFICE INCLUDES THE AREAS OF PHYSICS AND ASTRONOMY, PLANETARY EXPLORATION, LIFE SCIENCES, SPACE APPLICATIONS, AND TECHNOLOGY UTILIZATION. THE SPACE SCIENCE AND APPLICATIONS PORTION OF THE BUDGET CONTAINS THOSE PROGRAMS THAT ARE INFINITELY IMPORTANT TO THE SCIENCE COMMUNITY. PROJECTS LIKE THE SPACE TELESCOPE, ISPM, SPACELAB, GALILEO, LANDSAT-D,AND MATERIALS PROCESSING ARE NOT ONLY GOOD SCIENTIFICALLY, BUT THE RETURN ON INVESTMENT IN INCREASED STUDENT ENROLLMENT IN TECHNICAL DEGREE PROGRAMS, NATIONAL PRIDE, NEW ASTRONOMICAL DISCOVERIES, AND BUSINESS AND PRODUCT SPINOFFS ARE IMMEASURABLE.

I AM CONCERNED THAT WE ARE PLACING TOO MUCH OF OUR BUDGETARY EMPHASIS IN HARDWARE, AND NOT ENOUGH INTO THE

APPLICATIONS AREA. THE FY 1983 NASA BUDGET REQUEST INCLUDES A REDUCTION FROM 1982 OF $6.5 MILLION IN THE APPLICATIONS SYSTEMS AND TECHNOLOGY TRANSFER LINE ITEMS. THESE PROGRAMS HAVE HELPED IN THE PAST TO BRING A NUMBER OF SPINOFF TECHNOLOGIES TO THE PRIVATE SECTOR WHERE MANY HAVE BEEN TURNED INTO MONEY MAKING VENTURES.

A SECOND CONCERN OF MINE IS IN THE CONTINUING PROBLEMS OF PLANETARY EXPLORATION. THE ONLY ONGOING PROGRAM WE HAVE IS GALILEO, SINCE NO FUNDING HAS BEEN REQUESTED FOR VOIR. NOT ONLY HAS THE JUPITER MISSION BEEN CONTINUALLY DELAYED, BUT THE RECENT DECISION TO UTILIZE THE UNDERPOWERED IUS, INSTEAD OF THE CENTAUR UPPER STAGE, WILL DELAY GALILEO'S ARRIVAL TIME BY ALMOST TWO YEARS. WHEN THE SPACECRAFT FINALLY DOES ARRIVE, IT WILL ONLY BE ABLE TO MEET A LIMITED NUMBER OF MISSION OBJECTIVES. IT SEEMS TO ME, AGAIN, THAT THE DEPARTMENT OF DEFENSE IS THE DECISION MAKER FOR NASA POLICY -- SINCE DOD STATES THAT THEY WILL NOT REQUIRE THE CENTAUR BEFORE 1990, AND NASA CANNOT JUSTIFY THE CRYOGENIC UPPER STAGE FOR ONLY TWO MISSIONS. IS THIS A PRUDENT DECISION, OR ARE WE ONLY POSTPONING THE DEVELOPMENT COSTS FOR AN UPPER STAGE THAT WILL MEET DOD, NASA, AND PRIVATE PAYLOADS FOR WELL INTO THE 1990s?

FINALLY, THE OFFICE OF SPACE SCIENCE AND APPLICATIONS CONTRIBUTES MUCH TO THE PROGRAMS THAT ARE HIGHLY VISIBLE TO THE WORLD. IT IS ESSENTIAL FOR NASA TO CONTINUE THIS WORK THAT HAS MOVED THE AGENCY TO THE ROLE AS LEADER IN THE AEROSPACE SCIENCES, AND A STRONG CIVILIAN SPACE PROGRAM SHOULD BE AN INTEGRAL PART OF THE OVERALL PROGRAM.

THANK YOU, MR. CHAIRMAN.

Mr. FLIPPO. We understand that Dr. Edelson will give an opening statement and that Mr. Stofan will give the main statement with Mr. Keller and Mr. Anderson accompanying them.

Dr. Edelson, you may proceed. We are pleased to have you, and we look forward to having you in the future.

Mr. EDELSON. Thank you, Mr. Chairman.

Mr. FLIPPO. Before you begin, would the distinguished gentleman, the Representative from California, Mr. Brown, care to make an opening statement at this time?

Mr. BROWN. No, thank you, Mr. Chairman.

STATEMENTS OF DR. BURTON I. EDELSON, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE SCIENCE AND APPLICATIONS, NASA; AND ANDREW J. STOFAN, DEPUTY ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE SCIENCE AND APPLICATIONS, NASA, ACCOMPANIED BY SAMUEL KELLER, DEPUTY ASSOCIATE ADMINISTRATOR, AND PAUL ANDERSON, DIRECTOR OF ADMINISTRATION AND RESOURCES MANAGEMENT

Dr. EDELSON. I am very pleased indeed to be here in this maiden appearance. I have with me at the table Andrew Stofan who was the Acting Associate Administrator for Space Science and Applications until my recent appointment, and Sam Keller, the Deputy Associate Administrator, and also Paul Anderson, who is our Division Director for Administration and Resources Management for Space Science and Applications. I also have a number of members of the staff and division directors in the Office of Space Science and Applications who are prepared to discuss in detail any of the matters which are before you today.

I have been in my new position just 1 week, Mr. Chairman, and I am very happy to have this position and to be here today. I came to the position from the COMSAT Corp., so I am somewhat familiar with the technology and with the life in Washington, but I realize I do have a great deal to learn in this new position.

Although I have specialized in satellite communications during my career, I have also worked on the development of technology for a number of types of space programs. I have worked on everything from launch vehicles through satellite structures and technology, to scientific instruments. So, I speak some of the language that will be involved in the Space Science and Applications program with some experience in all these areas. I have not been directly involved in space science programs before, but I am looking forward eagerly to my association with such endeavors.

Obviously, I am not in position today to speak authoritatively about the details of NASA's space science and application programs nor the fiscal year 1983 submission. I can, however, summarize very briefly my attitude toward them which I think is of importance today.

I truly believe that there is an enormous payoff to be derived from our space program which manifests itself in at least three ways: In knowledge, in technology and in position through our efforts in space, I believe we have gained a great deal of knowledge about the solar system and beyond, about our environment, our in-

fluence on the environment, and about how we came to be. Indeed, we are using this knowledge to project and even plan our future.

Second, we have developed new technology in the space program—technology on materials, systems, techniques, and processes—and we have used this technology in space systems for communications to predict the weather, navigation, increase the safety of our astronauts in space, and for many other useful purposes. This technology has also been applied to life on Earth in many ways, such as computers, medicine, education, military systems. The space program also has enhanced the position of the United States as a leading Nation in space. We have demonstrated this leadership in major accomplishments such as the Apollo Moon landing and the Voyager mission to Saturn. We have led the world and created a global business in satellite communications. Perhaps, most importantly, we have enhanced our global reputation. Through space accomplishments we have increased the pride of our own people in themselves, in this Nation, and added immeasurably to the prestige we enjoy among other nations.

At this time when we are concerned about our relative position among nations, I think we should be very proud of NASA and its accomplishments. Aerospace technology is one of the few areas where we maintain technological leadership. NASA is, in fact, the best technology button the President of the United States has to push. If we wish to increase the level of technology in this nation, NASA is the best and most immediately available instrument for doing this.

That summarizes my basic attitude toward the space program as I approach my new position. I will try to do everything I can to maintain the high quality of science and technology development within the Office of Space Science and Applications and to define innovative and productive scientific and applications programs. NASA has accomplished much over the last two decades, and I hope to play a part in a productive future for the rest of the century.

Now I would like to ask Andrew Stofan, who has been the Acting Associate Administrator for Space Science and Applications until my recent appointment, to testify on the fiscal year 1983 budget request that is before you.

[The prepared statement of Dr. Edelson follows:]

HOLD FOR RELEASE
UNTIL PRESENTED
BY WITNESS
FEBRUARY 22, 1982

STATEMENT

of

DR. BURTON I. EDELSON
ASSOCIATE ADMINISTRATOR FOR SPACE
SCIENCE AND APPLICATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Good Morning. I am Burton I. Edelson, newly appointed Associate Administrator for NASA's Office of Space Science and Applications. I have been involved in the space program for over twenty years, but this is the first time I have had the privilege of being a part of the NASA organization. I am very pleased to appear before you now in that capacity.

Most recently, I served as Senior Vice President of COMSAT General, a subsidiary of the Communications Satellite Corporation. I joined COMSAT General in 1980 and was most recently involved in the development of advanced concepts for the corporation. My tenure at COMSAT included a number of years as Director of COMSAT Laboratories. In that position I was responsible for the entire research and development program of the Corporation. This involved work in all aspects of technology pertaining to satellite communications, including applied science, microwave and digital technology, satellites, Earth stations, and transmission systems.

I participated in the development of the technology for the INTELSAT international satellite communications system, the COMSTAR domestic system, and the MARISAT maritime system. Also, I directed efforts involving new uses for satellite communications, including electronic mail, newspaper transmission, computer networks, and broadcast and data distribution systems.

In 1979 I was elected as Vice President of the Corporation where I directed engineering efforts in the design, construction, launch and operation of satellite systems.

Before I joined COMSAT, I served as an officer in the Navy for over twenty years. After several tours of sea duty and postgraduate scientific education, I became an engineering duty officer. My first contact with the space program was in 1959 during the period when I was involved in the development of shipboard navigation equipment for the Navy. I developed the first equipment for the Navy transit navigation satellite program. The next step was the design and construction of the first satellite communications ship. These early experiences with space applications changed my Navy career significantly and influenced me to become ever deeper involved in space technology and space activities.

As a Naval officer, I served on the staff of the National Aeronautics and Space Council, a White House coordination group, and also with the Office of Naval Research in London, where I helped to develop the first British military satellite communications system and the NATO system.

While at COMSAT, I served on a number of space technology and research advisory committees for NASA, DOD, and the Navy Department. I had the privilege of serving on the Transition Team for NASA for the Reagan Administration.

Although I have specialized in satellite communications, I have also worked on the development of technology for all types of space programs--everything from launch vehicles to scientific instruments. I have not been directly involved in space science programs before, but I am looking forward eagerly to my association with such endeavors. Having been in my new position at NASA only one week, I am obviously in no position to speak authoritatively about the details of the NASA space science and applications programs. I can, however, summarize very briefly my attitude toward them.

I truly believe that there is an enormous payoff to be derived from our space program, which manifests itself in at least three ways: in knowledge, technology, and position.

- Through our efforts in space we have gained a great deal of knowledge about the Earth, the solar system, and beyond. We have gained knowledge about our environment, influences on the environment and about how we came to be. Indeed, we are using this knowledge to project and even plan our future.

- We have developed new technology in the space program on materials, systems, techniques, and processes. We have used this technology in space systems for communications, to predict the weather, to navigate, to increase the safety of our astronauts in space, and for many other useful purposes. This technology has also been applied to life on Earth in many ways--to computers, medicine, education, and military systems.

• The Space Program has enhanced the position of the United States as the leading nation in space. We have demonstrated this leadership in major accomplishments such as the Apollo moon landing and the Voyager mission to Saturn. We have led the world and created a global business in satellite communications. Perhaps, most importantly, we have enhanced our global reputation. Through space accomplishments we have increased the pride of our own people in themselves and in this Nation, and added immeasurably to the prestige we enjoy among other nations.

In this time when we are concerned about our relative position among nations, I think we should be very proud of NASA and its accomplishments. Aerospace technology is one of the few areas where we maintain technological leadership. NASA is, in fact, the best technology button the President of the U.S. has to push. If we wish to increase the level of technology in this nation, NASA is the best and most immediately available instrument for doing this.

That is pretty much my basic attitude toward the space program as I approach my new position. I will try to do everything I can to maintain the high quality of science and technology development within the Office of Space Science and Applications; and to define new innovative and productive scientific and applications programs. NASA has accomplished much over the last two decades, and I hope to play a part in a productive future that lies ahead for the rest of the century.

Now I would like to ask Andrew J. Stofan, who was the Acting Associate Administrator for Space Science and Applications until my recent appointment, to testify on the Fiscal Year 1983 budget request before you. He and Samuel W. Keller, Deputy Associate Administrator, and I will be happy to respond to questions from the Committee at the conclusion of Mr. Stofan's remarks.

Mr. FLIPPO. Thank you for your statement. I am certain you will make a very significant contribution to NASA's program and to the future of the Nation.

Please proceed.

Mr. STOFAN. I am very pleased to testify before you on the Space Science and Applications fiscal year 1983 budget request. Before I get into the details, I would like to take this opportunity to extend my thanks to this subcommittee. Over the past 4 years that I have been in Washington, we have had consistent and very strong support in the space science and applications programs and that is very much appreciated.

I would like the full statement entered into the record.

I will give you the highlights of the statement. I would like to review our reorganization and some highlights from the past year, briefly outline the budget request, looking at detailed elements of the space science and applications program, and talk briefly about some of the future missions that we are studying.

As you mentioned, this is the overall organization of NASA, showing the reduction in the number of slots, and also showing the centers that answer to the Associate Administrators (fig. 1). Now, I would like to look at the detailed chart showing the reorganization of the Office of Space Science and Applications (fig. 2). The Office has been organized into the major scientific and discipline thrusts. First, I would like to point out those elements of the organization that are unchanged. Elements from both the Space Science and former Applications programs remain the same such as the Materials Processing in Space, Life Sciences, Astrophysics, and Space Lab Flight Divisions. The only change was moving the Information Systems Office to be directly responsible to the Associate Administrator. This change focuses the attention of the Information Systems Office across the entire Office of Space Science and Applications. The Administration and Resources Management organizations were combined and some efficiencies were realized. The Goddard Space Flight Center and the Jet Propulsion Laboratory now answer directly to the Space Science and Applications Office. Many of the former elements of applications and science efforts were preserved.

One of the two major elements that has changed and has enhanced both the science and applications is in the environmental observations division which has incorporated magnetospheric physics and that part of the study of the sun which enables us to look at the Sun and the Earth as an entire fluid system. In one organizational level, we have been looking at the flow of energy out from the Sun down into tne magnetosphere through the atmosphere and down to the ocean itself.

Mr. FLIPPO. Has there been any change in the materials processing in space office?

Mr. STOFAN. The only change made involves the development of the one major instrument that will fly on the Shuttle was put into the spacelab flight division because of the technical expertise of the management. Otherwise materials processing remains exactly as it was before.

Mr. FLIPPO. The Center with the responsibility?

Mr. STOFAN. The Center's responsibilities have not changed at all.

NASA-S-82-10201

OEX EXPERIMENTS
PHASE I

- ACIP (AERODYNAMIC COEFFICIENT IDENTIFICATION PACKAGE)
- IRIS (INFRARED IMAGERY OF SHUTTLE)
- CSE (CATALYTIC SURFACE EFFECTS)
- TGH (TILE GAP HEATING)
- DATE (DYNAMICS, ACOUSTICS AND THERMAL ENVIRONMENT)
- SILTS (SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING)
- SUMS (SHUTTLE UPPER ATMOSPHERIC MASS SPECTROMETER)
- SEADS (SHUTTLE ENTRY AIR DATA SYSTEM)
- SSO (SUPPORT SYSTEM FOR OEX)
- ACME (AERODYNAMIC FORCE COEFFICIENT FLIGHT MEASUREMENT EXPERIMENT)
- RCIR (RCS CONTROL INTERACTION RESEARCH)
- SHARE (SHUTTLE HYPERSONIC AEROTHERMODYNAMIC RESEARCH EXPERIMENT)

The other major combination that occurred was in the Earth and Planetary Exploration Division, where geodynamics and Earth resource observations were combined with the planetary program. We believe that considering the Earth as a planet and looking at the synergism will enhance the study of the Earth. It is my view that these two organizational combinations have definitely strengthened both the applications and science parts of the program. When the combination was made, it was our intent to preserve all of the vital aspects of both the applications and the science programs, and I feel that we have accomplished that successfully.

I would now like to briefly review some of the highlights from the past year.

This shows (fig. 3) a collage of pictures taken by the Voyager spacecraft as they passed by Jupiter and Saturn. This trip highlighted the past 15 years of planetary exploration. At Jupiter and Saturn we went by the many satellites, discovered a ring around Jupiter, and made a detailed investigation of Saturn's rings that were a total surprise to the world. We studied the various satellites of Saturn. One of the advantages of having the second Voyager spacecraft was that we were able to reprogram the spacecraft to make a detailed investigation of the scientific phenomenon we had observed with the first spacecraft. This program has been extremely successful and has focused worldwide attention on the United States and on NASA for the technological leadership we displayed. One of the Voyager spacecraft is headed out of the solar system and the second one is targeted to encounter Uranus in 1986. We hope that the spacecraft system will remain in operation for an encounter with Neptune in 1989.

The Dynamics Explorer Mission are two satellites that were launched on the same vehicle in August 1981, (fig. 4). The satellites are to investigate the hot magnetosphere as it interacts with the cooler ionosphere and to look at the interchange between these two areas in order to provide imaging of the auroral zone and study of the dynamic motions of the aurorae. Both of these spacecraft are operating well, returning data, and, I might point out, were launched on time and developed within the cost estimate.

The Solar Mesophere Explorer (SME) will look at the chemical interactions in the upper atmosphere, particularly at the processes that form and destroy ozone. Figure 5 shows the ozone profiles taken by this spacecraft. The SME is healthy and is being operated by the University of Colorado. This spacecraft, like the Dynamics Explorer, was brought in on schedule and under the cost estimate.

I would like to briefly discuss one of the results from the office of space and terrestrial application, OSTA-1, mission flown on the second Shuttle test flight (fig. 6). There were several instruments on board, and we met most of the science objectives of this mission. Among the many instruments on board was the Shuttle imaging radar called Shuttle Imaging Radar [SIR-A] which covered 10 million square kilometers on the Earth with a resolution of 36 to 40 meters.

Figure 7 shows a picture of a radar image of oil rigs and vessels in the Persian Gulf, near Abu Dhabi. The left-hand part of the figure are ships, vessels, and oil rigs in the Gulf. The data from the

SIR-A are only half analyzed and we expect to complete the data reduction soon.

Some of the other images we have received show details like oil pipelines where the radar image reflects off the top of posts that hold the pipelines. We are now in the process of trying to understand the wealth of information that we obtained from this mission. I think one other thing that is very worthwhile is that this was the first time we have carried a scientific platform—Spacelab pallet—aboard the Space Shuttle. There was a great deal of concern about how much care and attention would be given to the science on board, vis a vis, the flying of the transportation system itself. I was very much pleased and so was the science community with the results of this mission even though it was shortened to two days. We obtained most of the science, with both the crew and the entire ground operations personnel going out of their way to maximize the amount of science returned. They were really interested in the science aspects of this mission, and this crew demonstrated the viability of the Shuttle as a science payload.

I will discuss briefly the highlights of the fiscal year 1983 budget starting with the space applications. In the presentation format, we show the March amended 1982 budget, the current fiscal year 1982 operating plan, and the fiscal year 1983 budget request, figures 9 and 10.

In space applications, between the fiscal year 1982 operating plan of $325.8 million and the request in fiscal year 1983 of $316.3 million, the budget remains relatively constant. One of the highlights is the Landsat-D which is coming along very well toward launch this July. I will say a little bit more about that later. The AgRISTARS program shows a substantial decrease from the March amendment but remains relatively stable between the operating plan and the fiscal year 1983 budget request. This program is planned to be phased out in the near future. The Department of Agriculture and other Government agencies will play larger roles with NASA playing a smaller role.

In environmental observations, we are developing instruments for the upper atmospheric research satellites [UARS] program and are presently defining the details with Goddard.

In technology transfer, we have $5 million in fiscal year 1982. The request in fiscal year 1983 is shown as zero. However, the aspects of the program that we feel are vital for technology transfer will be carried on in our basic applied research and data analyses [A.R. & D.A.] budget. For example, we will continue to support 16 universities, support several of the ongoing Government programs, and will emphasize the thermatic mapper basic technology transfer.

In Materials Processing in Space, the budget remains relatively constant, and again the basic program will continue. We are expanding our joint endeavor agreement with industry, an area that in the future could really begin to grow.

In the communications program, the fiscal year 1982 Operating Plan and the request for fiscal year 1983 budget request reflects a declining budget. This was due to the fact that a decision was made not to go forward at this time with a full demonstration project for the 30/20 gigahertz program. The other elements of the communi-

cations program have been preserved. Search and rescue, the technical consultation, and information systems have been running approximately at a constant level.

In physics and astronomy, the budget request from fiscal year 1982 to fiscal year 1983 shows a very large increase. This is primarily due to the space telescope. When you combine operations and development, we will spend approximately $170 million in fiscal year 1983 on the Space Telescope program.

We recently sent a letter to the committees requesting a reprograming of $2 million from the operations line item in space telescope to the development line item. This will ensure flexibility in effectively obligating our money for the optical telescope assembly that is being built for the space telescope.

Our International Solar Polar Mission development plans are to fly the European spacecraft with about half of the instruments on board from the United States. We will fly this mission using an IUS and a kick stage. I might also point out that Galileo mission will use the IUS and the kick stage, and we hope to make these two kick stages identical. They now are planned to be built by JPL. In the past, they appeared in the space shuttle budget. They now appear in our budget, which accounts for the increase shown in that area. An increase is also required for the revised mission design.

The Gamma Ray Observatory development efforts are moving from definition into full scale development.

In the Explorer development program, there is just one thing I want to point out that we missed putting it in our detailed testimony. We have added one element called Roentgen Satellite [ROSAT], an X-ray imaging satellite being built by the German Government. We are planning a cooperative program where we will provide a high resolution X-ray imager and the launch. They will provide the operations of the spacecraft, build the spacecraft and the other instruments. We will share totally in the data. We have a tentative agreement with the German Government, but we have not yet signed a final agreement.

I mentioned Galileo earlier. The Venus Orbiting Imaging Radar mission has been deleted as a line item in our budget. The mission operations and data analysis efforts will support the operation of the Voyager spacecraft, Uranus encounter, and the Galileo mission. The research and analysis will continue at a level below fiscal year 1982.

The life sciences line item includes research analysis and the payload development and these areas show an increase in fiscal year 1983. The increase is due to the fact that we are now starting to fly men in space repeatedly for short periods of time and therefore, enhancement in this area is necessary. We are also preparing for the first dedicated Life Science Spacelab mission.

Therefore, in total, we are looking at a budget of $894 million in fiscal year 1982, and are requesting just under $1 billion in fiscal year 1983.

This is approximately 11-percent increase in the office of space science and applications which is consistent with the overall NASA budget. Therefore, I feel in times of constrained economic conditions within this country, that this is a responsive budget.

I would like to talk about some of the detailed elements in the office of space science and applications. First, I will discuss the NASA astrophysics program which is designed to study Sun, stars, galaxies, and the entire universe. One of the extremely important projects we are working on is the space telescope. This will be one of the foremost astronomical instruments that will ever have been flown. It can detect objects 50 times fainter than can be detected from the surface of the Earth. The program is progressing very well. Figure 13 shows some of the various pieces of flight hardware that are now being developed. In the upper left-hand side is a solar array that is provided by the European Space Agency [ESA]. This is a joint program with ESA, and they are providing one of the scientific instruments as well as part of the personnel at the Space Telescope Science Institute in support of the science operations. Here, we show the primary mirror, the large focal plane structure, one of the scientific instruments, the graphite-epoxy metering truss, and the secondary mirror. These elements are now all being integrated into one system, and it is progressing very well.

Figure 14 shows a picture of the primary mirror, 2.4 meters in diameter. One can see the support structure on the outside and a plate covering the hole in the middle. The mirror has recently been coated and is the finest astronomical mirror that has ever been produced in the world.

Gamma Ray Observatory is getting into the major development phase and will answer many questions about exploding galaxies and quasars, and gamma ray bursts. These are objects which emit very, very intense bursts of gamma rays in less than a second, and continue to burst again and again. The Gamma Ray Observatory will address the most fundamental question of high energy physics in our universe.

The infrared astronomy satellite [IRAS] is shown on figure 16. The Netherlands provides the spacecraft and the operation of the spacecraft in orbit. We provide the telescope which operates with super fluid helium at about 2 degrees Kelvin. We have come before you with tales of IRAS and we have had our technological challenges with this program.

For example, some of the basic electric piece parts did not behave the way we thought they should. I am very pleased to say that for the first time in the last 2 years, everything on IRAS is going well. The spacecraft was integrated in Holland, and returned to the Jet Propulsion Laboratory where we put in a new rebuilt focal plane. The spacecraft now has been loaded with super fluid helium, undergoing chill down, and we are starting major telescope system tests which will be followed by the satellite thermal vacuum test. We will launch IRAS later this year.

The solar maximum mission [SMM], studies the detailed generation and flow of energy from the Sun. One of the reasons for mentioning this is because that the spacecraft, after approximately 1 year of operation lost the primary attitude control system on board and is slowly rolling. We also lost a chronograph, an instrument for measuring time variations in the solar corona. The spacecraft had returned a lot of good science data.

The SMM spacecraft is designed so that it can be repaired on orbit. What we are planning to do is fly a Shuttle up to the solar

maximum mission spacecraft, have an astronaut go out to the spacecraft, retrieve it, set it in the Shuttle, repair the one attitude control module, put covers over two of the instruments, and repair the chronograph and then place the solar maximum mission spacecraft back in orbit. This will restore the operation of the satellite which will be the only spacecraft we have over the next several years that will be observing the Sun. It is extremely important that this repair mission fits not only into the astrophysics program, but also into an entire environmental observations program.

A second benefit of this mission will be the demonstration for the first time of repairing a spacecraft in orbit. We also plan to do this with a space telescope in the future.

I would like to point out that from the perspective of the science and applications program which receives SMM data directly, we feel it is worthwhile to proceed with this repair mission.

The Earth and planetary exploration goals are to study the origins of the solar system, the origin of life, the present state of our planets, to survey near earth resources, and understand Earth through comparative studies, figure 18.

The Landsat-D′ is now undergoing integration and thermal vacuum testing (fig. 19). Two major instruments on board are the multi-spectral scanner and the thematic mapper [TM] which is a new instrument. The TM will be ready to launch in July.

Landsat-2 which is 7 years old, has suffered some degradation in the attitude control system, and it is no longer returning worthwhile data from the multispectral scanner.

Landsat-3 is still operating, although we are not getting a complete image transmitted. The data are of limited use. To insure continuity of data, we must get Landsat-D′ as soon as possible. The Landsat-D′ spacecraft is coming along well as a backup to Landsat-D′. Our plans are to turn the operation of Landsat-D′ over to NOAA 6 months after we launch it. We will however retain responsibility for operation of the thematic mapper until we know how to interpret the data. At that time, we will turn it over to NOAA for operation.

The Galileo is a mission to Jupiter with two primary objectives. One is to send a probe into the Jovian atmosphere where the theory predicts we will see water and ice clouds. The second part of this mission is the orbiter which will orbit not only Jupiter, but all of its major satellites with very, very close passes that will give us a wealth of the geological information. This program is currently on schedule. Figure 21 shows some of the flight hardware that is being built.

When we reconfigured the mission from a 1984 launch to a 1985 launch, we kept as much of the system on the 1984 development schedule as we could. We had a lot of subcontracts out; rather than terminate them and startover, we kept the development going. Therefore, the spacecraft is really being delivered earlier than it need be for a 1985 launch.

The flight hardware is coming along well, and there are no known technological, schedule, or cost problems at this time with Galileo.

We plan to launch Galileo with an IUS and a kick stage. This necessitates that we go on a Delta Vega trajectory which requires

that we launch the satellite, swing by the Earth to speed up the satellite for its flight, to Jupiter. The Delta Vega adds approxemately 30 months tc the trip time, and decreases the guaranteed satellite passes from 11 to 6. Under the best of circumstances, we will get approximately more than 6 passes at the satellites.

The International Solar Polar Mission (fig. 22) will also be launched on an IUS with a kick stage. It also is on a direct trajectory to Jupiter. As it flies by, the spacecraft will pick up energy from Jupiter which will bend the trajectory and it will fly back out over the poles of the Sun. The European spacecraft was kept on 1983 development schedule, and they plan to put it in storage at the end of development. Half of the instruments which will be flown on the ISPM spacecraft are U.S. There are no known problems at this time with the mission and it is progressing well.

We are conducting studies on Comet Halley (fig. 23). We do not have an independent NASA Halley mission; however, we are investigating the Comet Halley by the International Halley Watch which is funded by OSSA. It coordinates all of the ground observations from around the world and the world data bank will be in the United States. In addition. We are supporting the European Giotto mission, plus we have a Spacelab mission planned for observing Halley's Comet. The Japanese have a Planet–A mission which will be a Halley encounter. We plan to fly, what we call OSS–3 which is a pallet of instruments that will make ultraviolet imaging of the Comet Halley.

In the Environmental Observations division, our efforts involve advancing our knowledge and understanding of the atmosphere, oceans and climate (fig. 24). As I mentioned earlier in the Upper Atmospheric Research Satellite program, we have the instruments under definition and are working very closely with Goddard Space Flight Center at this time to define the exact configuration of the satellite (fig. 25). We will be considering this in the near future.

The Earth Radiation Budget Experiment (fig. 26) is called an experiment because we fly instruments on two of the NOAA satellites, and one NASA satellite. The two NOAA satellites are in a polar orbit. With the three spacecraft, we will be able to observe 80 to 90 percent of the radiation of the entire Earth.

Shown in the upper right-hand side of the figure is a solar irradiance measurement that illustrates an example of the daily irradiation of the solar output very large changes occur over relatively short periods of time. This is very important from our study of the Sun as a star but also because such changes in the radiation received on Earth may indicate changes in cloudiness, temperature, etc., all of which are important in our program.

Our climate program (fig. 27) studies long-term measurement requirements and modeling needs, required to understand and predict long term climate variations. We use many different parts of the program: the solar output, the Earth radiation, aerosols, clouds, atmospheric composition, snow and ice cover and precipitation among others to determine these variations.

In the weather and severe storms programs (fig. 28) which we are continuing to fund at a constant level—this shows some recent data we obtained using a lidar ranging technique to measure velocity vectors in the atmosphere (fig. 28). In the lower left-hand corner

it shows a gust front, that is where the air converges into a stray gust. Shown on the right-hand side is a result of what happens when the weather changes this way. This work is going along very well, and the techniques are being fed into the system for prediction of severe storms.

Our Life Sciences program is starting to pick up its tempo as we start to fly more and more Shuttles which means more of a varity of people in space. The primary function is the health and welfare of the astronauts in space. We look at operational medicine to determine the effects of space flight on man, life in the universe, advanced life support and also space biology.

Our Spacelab Payload Development and Mission Management efforts are coming along well and the budget has increased significantly from fiscal year 1982 to fiscal year 1983.

We develop principal investigator class instruments, fly mixed cargo missions like the data you saw which can fly with other communications satellites, and fly facility-class instruments like the solar optical telescope presently under development.

We have dedicated missions like the first Space lab flight, also a dedicated Life Sciences mission which is the fourth Spacelab mission. We are responsible also for the payload integration and test activities at the Kennedy Space Center for all NASA Spacelab payloads. We are also trying to define a science and applications platform.

Our materials processing in space program continues to include the fluids experiment system which flys in the Spacelab, and the monodisperse latex reactor which flys in middeck. In Biosciences and Materials Processing, there has been a great deal of interest from other organizations. We are beginning exploratory talks with them.

In the communications, we are looking at the state of the art and the long lead, high risk technology that should be pursued by NASA. As I mentioned, we are not proposing at this time to go ahead with the full-scale development program on the 30/20 gigahertz. We have reviewed that program in depth with the Lewis Research Center, and asked them to come back to us by April with different options of how the high technology could be demonstrated.

In the advanced programs area, we are looking at missions for possible start in the near future, such as the advanced X-ray telescope facility which has been under definition for the last few years (fig. 33). We are looking at doing the advanced technology on it now, such as polishing and grinding of mirrors. We are also looking at a Shuttle infrared telescope facility that will not only study unfrared effects from the Shuttle, but also could be offloaded onto a possible platform for long-term observations. In addition, we are investigating a gravity probe B mission that will test some of the very fundamental theories of relativity.

We are looking again at what is our next major thrust in planetary exploration. We are now studying a Venus mapper mission. The science objective of our original Venus orbiting imaging radar mission was to understand the surface features of Venus. The scientific questions remain a very high priority, and we are going

back to see if we can define a less ambitious mission that will answer some of those very fundamental questions.

The Solar System Exploration Committee, chaired by Dr. Hinners, will publish a report this summer to help shape the future of planetary exploration.

I really think that this study will set the future in planetary exploration.

In advanced studies for the Earth and Earth's environment (fig. 34), we have been looking for the last several years, at the origins of plasma in the Earth's neighborhood [OPEN] mission. This is a four-spacecraft system. We have now selected the instruments for definition and are now taking a very close look at the combination of the instruments into four spacecraft, so they can look at the Earth—Sun as an entire system and how it interacts. This mission is under definition and may be brought forward in the near future for consideration as a new start.

The ocean topography experiment [TOPEX] is a satellite that has a very accurate dual channel altimeter which will provide the first capability to measure global ocean circulation. This program is presently under definition. A gravity and magnetic satellite, a pair of satellites under investigation, will be considered in the 1984–85 budget process to be brought forward.

The multispectral linear array [MLA], which is the follow-on to the thematic mapper, is under development at this time and is coming along very well. Some time in the future, we will probably propose a Shuttle flight to demonstrate this new, high technology system.

I would like to conclude by saying that I think, given the economic conditions under which we presently operate, I think we have a healthy and balanced program, and we are looking forward to continuing a good relationship, with this committee in the future.

[The prepared statement of Mr. Stofan, plus answers to questions asked of Dr. Edelson and Mr. Stofan follow:]

February 22, 1982

STATEMENT

of

MR. ANDREW J. STOFAN
DEPUTY ASSOCIATE ADMINISTRATOR FOR
SPACE SCIENCE AND APPLICATIONS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

INTRODUCTION

Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to review the Space Science and Applications program and to discuss our proposed budget for FY 1983. For the last decade, the agency has brought forward separately a Space Science program and Applications program. Today, the programs are once again combined, and I believe that a few explanatory remarks concerning the philosophy and intent of the new organization are in order. The consolidation on December 3, 1981, of the Office of Space Science and the Office of Space and Terrestrial Applications into the Office of Space Science and Applications was part of a general reorganization of NASA Headquarters intended to assure more efficient delegation of authority to line managers and to simplify and clarify reporting lines for the field centers. (Fig. 1) In this arrangement, the Office of Space Science and Applications will have responsibility for the management of the Jet Propulsion Laboratory and the Goddard Space Flight Center, the two centers where most of the science and applications programs are located. We will, of course, continue to have important elements of our program at other centers and will be working very closely with the Associate Administrators for Aeronautics and Space Technology and for Space Transportation Systems to ensure that those elements are properly staffed, managed and directed.

In carrying out the reorganization, great care has been taken to preserve the strengths of NASA's science and applications programs. (Fig. 2) With this combination, I believe that we now can enhance our ability to understand the Earth as a planet and to study the complex coupling between the solar wind, the Earth's magnetosphere and the Earth's atmosphere in a comprehensive manner. One of the most important things we have learned in the 24 years of the space age is that comparative studies of the Earth and other planets lead to a deeper understanding of the general question of the evolution of planetary atmospheres and surfaces and of the influence of our space environment on the Earth itself. We now know that we cannot consider the Earth as an isolated body in space

gently warmed by the Sun's radiation. Rather, both the Earth and the Sun are part of a coupled system in which steady streams and intense bursts of atomic particles blow outward from the Sun, colliding with the atmospheres of the Earth and the other planets. At the Earth these particle streams provide the energy for the aurorae, magnetic storms, and the radiation belts. Lines of magnetic force, atomic particles and electric currents surround the Earth and interact with the atmosphere. We are only now beginning to understand how this coupling affects the Earth, its weather, its climate and our own communications.

There is no sharp dividing line between activities which can be called science and activities which can be called applications. Our total program is directed towards understanding the world we live in and the environment in which that world exists. Some of our program deals with the larger cosmic environment and the development of a very long-term perspective. Some of it deals with more immediate concerns such as atmospheric ozone, weather, climate, earthquakes, ocean currents, sea ice motion and natural resources, or with ensuring the health and effectiveness of our astronauts. The two aspects of the program are different sides of the same coin. They are equally important.

HIGHLIGHTS OF THE PAST YEAR

The strengths of the space science and applications programs are best illustrated by our accomplishments. I would like to review a few of the highlights of the past year.

Voyager 2

The Voyager 2 encounter with Saturn showed the great value of the two-encounter mission. (Fig. 3) Based on an analysis of the wealth of data returned by Voyager 1, scientists were able to reprogram Voyager 2 in order to study key areas of the Saturnian environment in great detail. Major objectives of the encounter included a comparative study of the atmospheres and magnetospheres of the two giant planets, Jupiter and Saturn, more detailed examination of the complex ring structure and a first close-up reconnaissance of several of the satellites of Saturn. The encounter, with closest approach to Saturn by Voyager 2 occurring on August 26, 1981, was a resounding success. Even the difficulties with the camera scan platform which occurred shortly after Voyager 2 passed through the ring-plane on its outbound journey did little to mar the success of the encounter.

Small-scale structure in the atmosphere of Saturn was identified including white ovals and alternating eastward and westward high-speed jet streams similar to those on Jupiter. Ultraviolet absorbent materials at the highest latitudes were discovered. Similar phenomena were observed at Jupiter and are thought to be due to complex hydrocarbons formed by auroral activity.

Basic new information on the structure of the rings was obtained. Few gaps were found to exist and those gaps which were identified were very sharply delineated. The imaging experiment showed eccentric ringlets in nearly every gap. Although gaps and eccentric ringlets suggest the presence of imbedded moonlets, a systematic search of the gap in the inner Cassini division revealed neither moonlets nor suggested any alternative explanation for the observed phenomena.

All 17 previously known satellites were observed, several from much closer range than that achieved by Voyager 1. There appears to be a tendency for the brighter satellites to be the most evolved. The darker ones are more primitive and of irregular shape, perhaps indicating the original rock and ice composition. Brighter, smoother surfaces may be the result of internal heating which has melted the icy crust. Recently, four and possibly as many as six, new small satellites of Saturn were discovered in the post-encounter examination of the Voyager 2 data. These are all small bodies, ranging in diameter from 10 to 20 kilometers.

Both Voyager spacecraft continue to speed toward the outer reaches of the solar system. It is estimated that Voyager 1 will cross the boundary of the heliosphere -- the bubble blown in the interstellar medium by the solar wind -- in 1990. It will be the first object launched from Earth to do so. Voyager 2 will encounter the planet Uranus in January 1986 and, if the spacecraft remains healthy, it will continue on to an encounter with Neptune in 1989. Both spacecraft will make continuous measurements to characterize the solar wind and await the onset of the flux of low-energy, cosmic ray particles from sources outside the solar system.

Dynamics Explorers

The two spacecraft of the Dynamics Explorers (DE) mission were launched on August 3, 1981. The mission is studying the interactions between the hot magnetosphere at high altitudes and the cool ionosphere at low altitudes, particularly the exchange of energy between the two regions, the acceleration of particles, and the processes that lead to aurorae. (Fig. 4) DE-1 is obtaining high resolution images which, for the first time, enable us to view the entire auroral zone and study the dynamic motions of the aurorae while particle streams, electric currents and plasma waves are simultaneously measured in situ by both DE spacecraft.

Solar Mesosphere Explorer

The Solar Mesosphere Explorer (SME), launched on October 9, 1981, is making measurements needed to understand the complex chemical processes taking place in the mesosphere, the Earth's middle atmosphere. (Fig. 5) Included in the data are measurements of the temperature and the concentrations of ozone, atomic oxygen, and nitrogen dioxide. The scientists working with these data have observed up to 30% variations in the ultraviolet reaching the Earth to drive mesospheric ozone reactions.

OSTA-1

OSTA-1, the Shuttle's first scientific payload, was launched on the second Shuttle flight on November 12, 1981. (Fig. 6) Although the mission was shortened, the OSTA-1 payload was an outstanding success demonstrating the Shuttle's capability to support scientific investigations. Over 10 million square kilometers of radar imaging data and 80 thousand linear kilometers of rock spectral reflectance data were obtained. (Fig. 7) The first global measurements of the distribution of carbon monoxide in the atmosphere and the first motion pictures of thunderstorms from space were obtained. Important data were also obtained on the distribution of marine algae in the ocean.

Visible Infrared Spin Scan Atmospheric Sounder

Flight of a Visible Infrared Spin Scan Atmospheric Sounder (VAS) on both GOES-4 and -5 has shown that temperature sounding is feasible to an accuracy of 1.5-2.0 °C from geostationary satellites. (Fig. 8) Land and water temperatures can be mapped to about 1 °C, once corrections have been made for atmospheric water vapor and clouds. Wind velocities can be calculated from short-term cloud or water vapor image displacements to within 2-3 meters/sec. Cloud height, type and cover estimation can be improved with the refined radiative transfer physics that is now possible using the increased number of infrared bands available on VAS. These data are helping NASA researchers to understand the development of severe storms. NOAA is pursuing the use of these new data products to enhance operational weather and marine forecasts.

BUDGET SUMMARY

The total budget request for FY 1983 for the Office of Space Science and Applications in Research and Development funds is $998.3 million. For your convenience, I will present the budget summary in the form familiar from past years. (Figs. 9 and 10) However, as I discuss the individual elements of the program in more detail, I will use an approach that more closely fits the new organization. Our Research and Program Management and Construction of Facilities requirements will be discussed in separate hearings.

The FY 1983 Budget request allows for continuation of ongoing development activities on our high-priority projects. It supports the continuation of the Landsat-D development leading to a launch in 1982; continues the space telescope development leading to a launch in the first half of 1985; continues the Galileo development leading to a single Shuttle/Inertial Upper Stage launch in 1985; and continues development of instruments and support for the single spacecraft International Solar Polar Mission to be launched in 1986 on a single Shuttle/Inertial Upper Stage. The Spacelab payload development, Explorer development, as well as our research and other support efforts are also continued at a viable level.

With the new reorganization, we are looking at the possibility of combining some capabilities that exist within the Science and Applications areas of endeavor to determine if some economies can be accomplished. In addition, we have taken and are continuing to take, a look at some of the activities that NASA has supported in the past to determine those that are more appropriately the responsibility of the private sector.

In Resource Observations, requested funding will continue to support a third quarter 1982 launch of Landsat-D. Extended mission operations funds will provide for continued Landsat 2 and 3 operations. Planned Shuttle/Spacelab Payloads funding will support future flights of the Large Format Camera. The Geodynamics Program will continue its efforts to improve our understanding of the dynamic processes that occur within and at the surface of the Earth. The AgRISTARS program will continue to develop methods for assessing worldwide agricultural resources by identifying and separating the remote sensing signatures of various forms of vegetation. The Applied Research and Data Analysis effort will continue to develop new remote sensing capabilities, with particular emphasis on advanced solid state sensor development.

In Environmental Observations, requested funding for the Upper Atmospheric Research program will enable us to continue to carry out our Congressional mandate to improve our understanding of the upper atmosphere. Requested funding for Shuttle Spacelab Payloads development will support analysis of data from environmental instrumentation on OSTA-2 and will support completion of the Atmosphere Trace Molecules Observed by Spectroscopy (ATMOS) instrument for future flights. We plan to phase out the Operational Satellite Improvement Program. The budget request assumes NOAA will pick-up the responsibility for future operational satellite system improvements. NASA expects to complete ongoing development of instruments such as the Solar Backscatter Ultraviolet Radiometer (SBUV) and spacecraft systems which directly support NASA's research goals. Funding requested for the Earth Radiation Budget Experiment (ERBE) spacecraft will support a 1984 launch. The ERBE instrument development activities will also continue to prepare for launch on NOAA spacecraft beginning in 1983. However, actual launch dates that NOAA can support are currently under review. Mission operations funding will continue to support the operations and data analysis of the Solar Mesosphere Explorer and the extended Nimbus-7 mission. The Upper Atmosphere Research Satellite experiments have been selected and detailed design and development will begin in FY 1983. Spacecraft and ground data handling system definition for this mission will also continue. We have altered our planning for the Halogen Occultation Experiment from flight on the Earth Radiation Budget Satellite to flight on another spacecraft. It has been tentatively selected to fly on the Upper Atmosphere Research Satellite Mission.

The Technology Transfer program, which has the objective of transferring Landsat-type technology application to public and private organizations, is being phased out by NASA. The Congressional addition for this program in FY 1982 is being used to examine ways to transfer these efforts more systematically to the private sector. We do, however, expect to continue the most important basic research efforts on the utilization of Landsat-type technolcgy with applied research and data analysis funds.

Our Materials Processing in Space program continues to focus on the use of the zero-g environment to obtain new insights on the basic properties of materials. The Shuttle/Spacelab Payloads Development and Material Experiment Operation budget request will provide the development of flight experiments such as the Vapor Crystal Growth System and support extensive ground based experimentation using sub-orbital flights, drop towers and drop tubes.

In Communications, the requested Applied Research and Data Analysis funding is consistent with the policy decision to develop basic technology but not to pursue efforts leading toward large hardware demonstrations. The Search and Rescue Program will continue with the first launch in this co-operative program scheduled for 1982. Technical consultation and support studies on world-wide communication problems will continue at the previously presented FY 1982 level and the Experiment Coordination and Operation Support line will continue to support the ATS -1, -3 and -5 operation and experimentation.

In order to increase our confidence that we can achieve our technical and schedule goals during this initial phase of development, we plan to increase the FY 1982 funding for Space Telescope by $2.0 million. A reprogramming

letter is being submitted to Congress detailing the reasons for requesting this change. The requested FY 1983 funding will support fabrication, assembly and test of the Space Telescope. This tremendously exciting project continues moving successfully toward a launch in 1985.

Requested funding for the International Solar Polar Mission will support the ESA single-spacecraft mission with NASA providing launch, tracking and several instruments. The FY 1983 funding will provide for the continued development of the U.S. instruments. These funds are also required for the development of a kick stage and interstage to accommodate the recent switch from a Shuttle/Centaur to a Shuttle/Inertial Upper Stage launch in 1986.

Requested FY 1983 funding for the Gamma Ray Observatory will provide for detailed design and initiation of flight hardware procurements. We continue to proceed toward launch in late 1988.

In the Shuttle/Spacelab Development and Mission Management area, consistent with Congressional actions, the FY 1982 funding has been increased by $5 million. This increase allows us to accelerate the first flight of the Large Format Camera. Requested funds in FY 1983 will support the development of Physics and Astronomy Instruments and also provide for the mission management activities required to support all NASA Spacelab payloads. The increased funding requested in FY 1983 reflects the fact that with the first flights of the STS having taken place we are now planning to substantially build up our Shuttle/Spacelab Payloads program.

FY 1982 Explorer development funding will support ongoing development activities of the Infrared Astronomy Satellite and lead to a launch in 1982. The FY 1983 funds will support the ongoing development of the Active Magnetospheric Particle Tracer Explorers and the Cosmic Background Explorer.

Physics and Astronomy Mission Operations and Data Analysis funding shows a slight increase over the FY 1982 Amended budget level. The FY 1982 increase is due to the inclusion of funding for repair of the Solar Maximum Mission. In December 1981, the Committees were provided an initial notification of NASA's plan to carry out the planned repair of SMM. As I will discuss later, we believe that this repair is extremely important, justifying the changes we would like to make to accommodate it. The FY 1983 request will support the required buildup in activities supporting the Space Telescope for its operations beginning in 1985 and its later maintenance and refurbishment.

Research and Analysis funding in Physics and Astronomy will continue to support fundamental research in many areas, conceptual development of possible future missions, development of the new technology required to support these missions, and extended analysis of data from past missions.

In our Physics and Astronomy suborbital program -- Sounding Rockets, Airborne Research, and Baloon flights -- we will be able to support over 50 sounding rocket flights, approximately 65 flights of the Kuiper Airborne Observatory, and approximately 20 balloon flights.

The Planetary Exploration Program continues at a viable level. Galileo funding in FY 1982 has been increased by $12 million over the March request to provide for the development of a kick stage and interstage to accommodate the

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launch on a Shuttle/Inertial Upper Stage rather than a Shuttle/Centaur as assumed in the March request. The launch vehicle change will require an Earth fly-by trajectory to pick up the necessary energy to accomplish this mission, resulting in more than two-years additional trip time and a reduction in the number of satellite encounters. A letter notifying Congress of the proposed reprogramming, and setting forth the justification for this action is being prepared. The FY 1983 funding request supports continued development of the Galileo project leading to launch in 1985.

Due to the need to continue ongoing high priority space science and applications projects within the requested buget, development of the Venus Orbiting Imaging Radar mission cannot be initiated. We will, however, continue advanced definition efforts on concepts for a Venus mapping mission with our Research and Analysis funds.

The FY 1982 Planetary Mission Operations and Data Analysis funding will support those activities absolutely necessary for Voyager and Galileo. We are considering the impact of significantly curtailing or terminating operation and data analysis for the Pioneer Venus Orbiter and Pioneers 6 through 11. Voyager operations will be continued leading to an encounter with Uranus in 1986.

Research and analysis provides for the Infrared Telescope Mid-level Facility. We are reviewing the possibility of curtailing efforts on processing of Lunar samples, planetary astronomy and analysis of data from past missions. We may also have to stop operations of the Infrared Telescope temporarily.

The Life Sciences Program shows some growth over the level of previous years.

Requested FY 1983 funding for Life Sciences' Shuttle/Spacelab Payloads Program will continue the development of experiments for flight on the STS that will help us understand the effects of weightlessness on man. In particular, the request will support development payloads for Spacelab 4, a mission we believe will be a key step forward in understanding medical problems associated with manned space flight.

The Life Sciences Research and Analysis Program will continue to support ground based research and future program and experiment definition.

The budget I am going to present recognizes support of the President's economic recovery program. It is important to realize that it does permit continued development of our highest priority large scale space projects: Space Telescope, Galileo, Landsat-D, the Gamma Ray Observatory and Upper Atmosphere Research Satellite Experiments. It also permits our continued participation in the one-spacecraft International Solar Polar Mission. Development will continue on several important projects of more modest scale, such as the Earth Radiation Budget Experiment, the Active Magnetospheric Particle Tracer Explorers, the Cosmic Background Explorer and the Solar Optical Telescope experiment. It allows for the continued operation of our most scientifically productive satellites and space probes such as the International Ultraviolet Explorer, the Nimbus-7, the International Sun-Earth Explorers, the Solar Mesosphere Explorer and Voyager. It supports a scientific and technical base which will enable us to undertake a program of increased scope in the future when economic conditions permit us to do so.

I will turn now to a more detailed discussion of the major elements of the Space Science and Applications Program. For the remainder of my statement, I will refer to the new organizational structure in describing the contents of the program.

ASTROPHYSICS

The goal of the Astrophysics Program is to understand the origin and evolution of the universe and the fundamental laws of physics that govern cosmic phenomena. (Fig. 11) To achieve this goal, we must observe the universe in every band of electromagnetic radiation--from the shortest wavelengths of gamma radiation to the longest radio waves. Much of the spectrum is inaccessible from the ground and can only be observed from space.

Space Telescope

The Space Telescope (ST), a collaborative program with the European Space Agency (ESA), for which we are requesting $137.5 million in FY 1983, will be the flagship of the Astrophysics program. (Fig. 12) When it is launched in 1985, it will be the most powerful observatory ever built. Space Telescope will image astronomical bodies with at least ten times finer resolution than can be achieved by telescopes observing through the Earth's atmosphere, and it will detect objects fifty times fainter than the largest ground-based observatories. As a result, we will use it to attack a wide variety of frontier problems in astrophysics, particularly in the areas of extragalactic astronomy and observational cosmology.

Substantial progress has been achieved on the Space Telescope development and its focal-plane instruments. (Fig. 13) Design activity reached its peak in FY 1981, and fabrication and assembly of flight hardware has begun. Perhaps the most significant achievement has been the completion of the primary mirror. (Fig. 14) The surface departs from a perfect figure by no more than a few millionths of an inch. The primary mirror was successfully coated in December 1981, and the coating is well within specifications for both the visible and the ultraviolet. In addition, the secondary mirror was ground, polished and coated, and the two mirrors are now ready for integration into the telescope. Main structural parts for the Optical Telescope Assembly have been completed. We are now beginning the early integration process. Significant progress has been achieved in fabricating the scientific flight instruments. Design of the spacecraft Support Systems Module (SSM) is nearing completion. Spacecraft manufacturing activity for the Support Systems Module will begin after the Critical Design Review which is scheduled for March 1982.

During the past year, the Association of Universities for Research in Astronomy (AURA) was awarded a contract for management of the Space Telescope Institute. Ground was broken for its new facility at the Johns Hopkins University in Baltimore, Maryland, and staff members are being brought on board.

During FY 1982 emphasis is shifting from design to manufacturing, assembly, and testing. In FY 1983, the Optical Telescope Assembly and the Support System Module will near completion, and testing of all scientific instruments will take place.

Gamma Ray Observatory

We are developing the Gamma Ray Observatory (GRO), for which we are requesting $34.5 million in FY 1983, to explore the universe in the highest energy portion of the electromagnetic spectrum. (Fig. 15) The GRO will allow a penetrating look at the nuclear processes occurring near neutron stars and black holes and will permit investigation of the formation of elements in supernovae, the origin of gamma-ray bursts, and details of the physical nature of the recently discovered gamma-ray sources in the galaxy. The observatory will move gamma-ray astronomy from its infancy to a phase where we can begin the detailed study of the nuclear and elementary particle universe.

We have made substantial progress on this program. In FY 1981, the agency selected the mission systems contractor, initiated the spacecraft design, confirmed four scientific instruments, and initiated the instrument development contracts. During FY 1982, we will continue spacecraft and instrument design, complete specifications for the spacecraft subsystem, and essentially complete engineering models of the instruments.

We will begin hardware development of both spacecraft and scientific instruments in FY 1983. This activity will involve procurement of long-lead hardware items, completion of a major portion of spacecraft and instrument design, and critical design reviews of most of the instruments. The Gamma Ray Observatory launch is planned for late 1988.

Infrared Astronomical Satellite

The Infrared Astronomical Satellite (IRAS) will open up a truly new frontier, the universe of cool and cold objects. (Fig. 16) In the last year, significant progress has been achieved on the IRAS, and we expect to launch it late in 1982. In FY 1981, the Dutch-built spacecraft was assembled and successfully tested, while in England the ground-tracking station has been equipped. The software for the mission has been installed and is currently under test. In the United States, the Infrared Telescope System was completely assembled and shipped to The Netherlands for integration with the spacecraft and for satellite vibration testing. After successfully passing these tests, the satellite was returned to the Jet Propulsion Laboratory in Pasadena, and environmental testing is now underway in preparation for the launch. FY 1982 funding will be used to complete the necessary work prior to launch.

In the past, infrared astronomy has been conducted from mountain tops, high-flying aircraft, balloons, and sounding rockets. The early observations have shown that many celestial objects emit the bulk of their radiation at the infrared wavelengths covered by IRAS. Regions where stars are being formed, for example, often emit more radiation in the infrared than 10,000 suns emit over all wavelengths. IRAS will survey the outer solar system for asteroids -- small, minor planets with temperatures far below freezing -- and we expect it to detect thousands never before seen. Theory predicts that many burned-out stars should be detectable even though they have consumed their nuclear fuel. IRAS will give us our first road map to the interesting objects in these wavelengths.

Cosmic Background Explorer

The next addition to the Explorer series, the Cosmic Background Explorer (COBE), will be started in the second half of FY 1982. COBE will be the first satellite to be designed specifically to observe details of the Big Bang--the explosion thought to have marked the beginning of the universe. Echoes of the Big Bang were discovered in 1965 as microwave radiation coming to us from all directions of the sky. COBE will carry instruments high above the interference of the Earth's atmosphere to map this radiation at a large number of different wavelengths. The maps will help us decide whether the primeval explosion was turbulent or uniform, whether it occurred simultaneously everywhere, and how the first galaxies were formed. The resulting observations will provide fundamental new information on observational cosmology, complementing the cosmological studies from Space Telescope.

The COBE Project has completed the definition review of the spacecraft and scientific instruments. Breadboard versions of the key components and subsystems of the scientific instruments are being assembled for tests. In addition, the spacecraft system configuration has been defined, and subsystem trade-offs are being assessed. During FY 1983, the COBE project will complete the detailed design and will procure items requiring long manufacturing lead times.

Operational Satellites and Data Analysis

Nine satellites are now operating under the management of the Astrophysics division. The currently operational missions are the three International Sun-Earth Explorers (ISEE), the International Ultraviolet Explorer (IUE), and the Solar Maximum Mission (SMM). Interplanetary Monitoring Platform IMP-8, data analysis will be continued through FY 1982. The Solar Mesosphere Explorer (SME) and the pair of Dynamics Explorers (DE) are currently undergoing final post-launch check out and are scheduled to be placed into full operational status in the near future. Operation and analysis of data from IRAS will be included in this program once the satellite is launched.

Besides these active missions, we continue to support, analysis of data from the High Energy Astronomy Observatories (HEAO), the Orbiting Astronomical Observatories (OAO), and the Atmospheric Explorer (AE).

High Energy Astronomy Observatory

The High Energy Astronomy Observatory (HEAO) program has been very successful, producing many new results about a wide range of astrophysical objects. All three HEAO satellites have fully completed their mission objectives and have ceased operation. Nevertheless, analysis of data from the HEAOs continues to bring us new and dramatic information about the violent and explosive components of the universe. One of the particularly interesting results from the HEAO program is the new perspective it has given us on stars. Together with the IUE, HEAO has shown us that chromospheres, coronas and winds observed on the Sun are far more common in all types of stars than previously thought. This new perspective is leading to greater interaction between stellar astronomers and solar physicists, to the benefit of both.

Solar Maximum Mission and Solar Maximum Mission Retrieval/Repair

The Solar Maximum Mission (SMM) was launched in February 1980. (Fig. 17) It was able to operate with a fixed orientation toward the Sun until part of the attitude control system was lost in late 1980. Since that time the spacecraft has been spinning slowly with its principal axis toward the Sun so that three of the seven experiments continue to collect valuable data.

As a result of the ongoing analysis of solar flares observed by SMM, we have been able to obtain a much firmer understanding of the origin of flares. We are now certain that the energy for flares is derived from magnetic fields which emerge from the Sun's surface and form arches, about 30,000 miles across, that reach up into the corona. The collision of two field loops triggers the conversion of magnetic energy at the top of the loop into the acceleration of subatomic particles to relativistic speeds. SMM has made the first picture ever of the hard X-rays emitted when these particles strike the solar surface at the footpoints of the magnetic arch. Other observations have shown the explosive expansion of the lower atmosphere when heated by the high-speed particles and the eruption of flaring loops into giant disturbances in the outer solar corona.

In order to continue the exceptionally successful scientific progress made by SMM and to demonstrate the retrieval/repair capabilities of the Space Shuttle, we are planning an in-orbit repair of the SMM spacecraft and instruments. An astronaut, flying freely with the aid of a Manned Maneuvering Unit, will rendezvous with SMM, stabilize it, and attach a grappling device for use by the Shuttle's Remote Manipulator System (RMS). Once the RMS has taken hold of the SMM, the spacecraft will be locked into the Flight Support System in the Shuttle cargo bay where module exchange of the attitude control system and instrument repair will be performed before the spacecraft is redeployed. A repaired SMM will provide for several years of continued studies of solar flares, solar atmospheric dynamics, and the total energy output of the sun. However, we believe that the SMM repair has much broader importance than SMM itself. It will be the first demonstration of the Space Transportation System's ability to service a satellite on orbit, an important precursor to our planned operations with Space Telescope, as well as the on-orbit repair and servicing of other types of satellites.

EARTH AND PLANETARY EXPLORATION

The Earth and Planetary Exploration Program has been created by combining the Solar System Exploration Program and the (Earth) Resource Observations Program. This new program has responsibility for planetary science research for all of the planets including Earth, as well as the responsibility for continuing to pursue techniques that can materially assist us in the management and utilization of renewable and non-renewable resources. (Fig. 18) I believe that the common scientific thread that runs through all the research activities will serve to strengthen significantly the new, enlarged program. The program being presented today represents a significant restructuring in the planetary area.

Landsat-D

Landsat-D, for which we are requesting $61.7 million in FY 1983, is the latest satellite in the highly successful Landsat program. (Fig. 19) It will provide significantly improved capabilities for the remote sensing of agricultural and natural resources. The satellite's instruments have greater spectral coverage, particularly in the mid-infrared region, and improved spectral and spatial resolution over its predecessors.

During the past year the Landsat-D program has made excellent progress: the spacecraft is now in its acceptance test cycle and on schedule for a summer 1982 launch. All flight hardware elements needed to support the Landsat-D launch have been delivered and integrated with the spacecraft. These include the Multispectral Scanner (MSS), the Thematic Mapper (TM), the Multimission Modular Spacecraft, and the Wideband Communication subsystem. Integrated operation of all elements has been satisfactorily verified without significant problems. We are particularly interested in the TM data, which may open new frontiers of data applications in remote sensing in the coming years.

Progress in the Landsat ground segment development during the past year has been significant. All data processing hardware elements have been integrated into the various ground segment facilities needed to support the launch. These include the Control and Simulation Facility which will control the spacecraft, the mission management facility which will control the many operations of the entire ground complex, the Image Generation Facility which will process the MSS data into geometrically and radiometrically corrected data products, and the Landsat Assessment System which will be used to verify the quality of the Landsat data products and assess their utility for improved data extraction techniques. Development and integration of the data processing software is nearing completion.

During FY 1983, Landsat-D MSS operations and the distribution of MSS data products will be initiated. The TM data processing system will build up from a capability of handling one scene per day at the Landsat-D launch date to 12 scenes per day by mid-1983. During the first year of Landsat-D operations, the TM orbital performance will be characterized. The 50 scenes per day TM requirement should be achieved by early 1985.

During FY 1983, the Landsat-D' spacecraft will be integrated and launch readiness testing completed. If not needed as back-up for Landsat-D, it will be placed in storage and launched after the Landsat-D operational lifetime.

NASA currently plans to turn over control of the Landsat-D spacecraft and MSS data processing to NOAA six months after launch. TM data processing and TM R&D responsibility will remain with NASA until the system is considered fully operational. The details of the turnover are still being negotiated with NOAA.

Landsat Utilization

There continues to be widespread use of Landsat data. For example, in FY 1981, Applications Systems Verification and Test (ASVT) projects were completed with the National Park Service; with the States of Washington, Idaho and Oregon

and the Pacific Northwest Regional Commission; and with the State of Texas. The States of Washington, Idaho, Oregon, and Texas have already established operational Landsat data processing systems, and the National Park Service has requested funding for such a system at its Denver Service Center. A3VT projects with Pacific Gas and Electric, Florida Water Management Districts, and the States of Alaska and California will be completed in FY 1982. These projects have shown that Landsat data when combined with data from other sources, can provide a capability greater than that previously available.

Nationally, a growing community of users of Landsat data is emerging. "A Survey of State Applications of, and Investments in, Landsat Technology" published by the National Conference of State Legislatures and the Council of State Planning Agencies in May, 1981 jointly reported that 26 states have developed, or are developing capabilities to use Landsat data. Approximately 400 applications are defined by states as routine and continuous. State investments include $28 million of expenditures (not including personnel costs) since the first satellite was launched in 1972 of which $5 million were expended specifically for the acquisition of software and hardware.

In FY 1983, we will continue grants to fourteen universities to conduct discipline-oriented research in space applications, and to test and evaluate remote sensing techniques. This funding will maintain centers for the development, test and evaluation of new remote sensing technology, such as the Thematic Mapper, together with centers for basic and applied research in geology, geodynamics and materials processing.

AgRISTARS (Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing)

AgRISTARS is a program of research, development and testing which deals with the management of domestic resources and the provision of information on the global condition and production of commodities. The program is conducted in cooperation with the U.S. Department of Agriculture (USDA) and NOAA, with support from the Department of the Interior, to serve the program needs of USDA. We are requesting $15.0 million in FY 1983 to continue to support AgRISTARS in selected research and development activities requiring NASA's specialized capability. Since NASA is only one of the several agencies implementing the total AgRISTARS program, our activities must be undertaken in consonance with the FY 1983 plans of the other agencies. While coordination is not yet complete, it is clear that presently planned program schedules and the program scope will have to be modified. As part of the program restructuring, responsibility for the pilot testing activity will be terminated by NASA under the assumption that the Department of Agriculture will pickup the efforts. Discussions concerning the future of the program are currently underway with USDA.

Automated techniques for the analysis of Landsat data have progressed to the point where analysis and computer processing times are no longer significant limitations to the efficient use of the technology. Substantial progress also has been made in our ability to separate the signature of small grains, particularly corn and soybeans at or near harvest. The improved capability available with the Thematic Mapper holds promise of much improved

separability of corn and soybeans at earlier growth stages, and for accommodating a wider range of agricultural conditions. Research in quantifying the impact of abnormal weather conditions on crop yield has produced models for estimating losses occurring when rain falls during wheat harvest, and the effect of hot dry winds on crop yield.

Some specific objectives to be addressed during the FY 1982-83 period include: completion of a multiple crop technique development activity; continued research on classification techniques emphasizing spatial information; continued research on understanding the physical processes that influence reflected or emitted energy from scene elements; and, continued development of a statistical theory for sampling remotely sensed data.

Geodynamics

We are requesting $26.2 million in FY 1983 to continue studies of the solid Earth including movement and deformation of the crust; gravity and magnetic fields; and rotational dynamics. These studies contribute to our understanding of crustal hazards such as earthquakes, and are important in understanding how the Earth is evolving and how the solid Earth interacts with the oceans and the atmosphere.

The Earth's lithosphere consists of roughly seven major continental-sized blocks or plates a few hundred kilometers thick, and a number of smaller plates, all of which are moving with respect to one another at rates up to 15 centimeters per year. The plates move almost as rigid bodies, but the tiny deformations where they are in contact are largely responsible for earthquakes, mountain building, and other geological phenomena.

We first began to measure the relative movement of the Pacific and North American plates in 1972 using laser ranging to satellites from opposite sides of the San Andreas Fault. These measurements have been made every two years since that time, most recently in 1981. Over this ten year span the relative motion along the San Andreas Fault averages about 8 cm/year, far in excess of the 5.5 cm/year predicted by global geological and geophysical evidence. To explain these discrepancies, the density of measurements along the San Andreas Fault System was increased this past year. We currently plan to repeat these measurements each year through 1987, to determine the rate of deformation between sites and to develop a model of crustal strain accumulation associated with the San Andreas Fault System. Similar studies of crustal deformation in Alaska and joint studies of Pacific plate motions with Japan have been delayed.

Monitoring of the dynamical motion of the Earth about its axis of rotation over the past 100 years has established that the Earth's polar axis wanders over a roughly circular path with a mean diameter of 10-15 meters and that the length of day varies by several milliseconds per day. While much is known about the gross nature of these motions, the physical explanations have escaped us because of limitations on the accuracy of observations. The improved accuracy available with laser and microwave interferometric techniques (about 10 cm), now are providing definitive evidence of short period variations in polar motion. Variations in length of day have been correlated with changes in the total angular momentum of the upper atmosphere. When the atmospheric

effects were subtracted from observed Earth rotation measurements, a previously unknown periodicity of 50 days in the variation of the Earth's rotation rate was discovered. This periodicity is being studied in order to identify its origin.

The Geodynamics Program is being coordinated through formal agreements with other Federal Agencies (NOAA, USGS, NSF, and DMA) and we are participating in international programs to use space technology for global studies of geodynamics. Within the United States, three new geodetic services using space methods are being planned: a National Crustal Motion Network by NOAA, beginning in 1984; an improved Polar Motion and Earth Rotation Service (Polaris) jointly developed by NASA and NOAA to be operational in 1983; and a Local Crustal Motion Network monitored by the USGS using the DOD Global Positioning System.

Galileo

I will turn now to our solar system exploration program by discussing the Galileo Mission to Jupiter which remains the centerpiece of the planetary part of our program. The Galileo mission, for which we are requesting $92.6 million in FY 1983, will carry out a thorough exploration of the giant planet Jupiter, following up on the Voyager discoveries. The mission consists of an orbiter that will provide imaging, remote sensing and magnetospheric measurements of Jupiter and its satellites. In addition, an atmospheric probe will obtain in situ measurements of Jupiter's chemical composition and physical state. (Fig. 20)

Our plans for completion of the Galileo mission, a cooperative mission with the Federal Republic of Germany, have been changed. We now plan to launch the combined Galileo orbiter and probe using a Shuttle/Inertial Upper Stage plus an auxiliary kick stage instead of a Shuttle/Centaur launch. The major change in the mission will be the type of trajectory used to reach Jupiter. Approximately one year after launch, an apogee burn will be performed by the spacecraft kick stage to properly target the spacecraft to re-encounter the Earth for a gravity assist in mid-1987. The spacecraft will then proceed on its transit to Jupiter, arriving in early 1990.

Critical Design Reviews for both Orbiter and Probe systems as well as all subsystem and component levels have been completed, and flight hardware production is underway on almost all elements. (Fig. 21) A substantial amount of hardware has, in fact, already been delivered. The new launch strategy is designed to minimize the impact to the development program by allowing development of orbiter and probe spacecraft to continue unchanged. The only new element is the addition of the kick stage and interstage development. The cost estimate for the kick stage and the associated mission modifications are under review. The cost and schedule for all other elements are virtually unchanged from the 1985 Centaur launch.

The Galileo mission has been designed to return the maximum amount of information possible. The 1985 mission takes full advantage of the funds obligated to date and preserves the complete scientific potential of the mission. Although we have had interruptions in the development of this mission, we continue to make substantial progress and our German partners remain committed to the mission.

International Solar Polar Mission

The cancellation of the U.S. spacecraft portion of the International Solar Polar Mission (ISPM) has now been fully implemented. (Fig. 22) We are still fully supporting the remaining European spacecraft and the U.S. experiments carried as part of its payload. A special study conducted by the National Academy of Sciences in the summer of 1981 confirmed that a single spacecraft mission would perform a valuable first reconnaissance of interplanetary phenomena far from the Sun's equatorial plane and of the three-dimensional properties of the solar wind.

The ISPM payload contains nine separate investigations of which five have U.S. principal investigators. Of the 79 principal and co-investigators still involved, 29 are from the United States. Three of the four European investigations have U.S. co-investigators. Thus, the U.S. scientific involvement is substantial. In addition, the United States will provide the radioactive thermal power generator, launch services and tracking and data acquisition for the mission.

The launch of the ISPM spacecraft will utilize the Shuttle/Inertial Upper Stage (IUS) augmented by an auxiliary propulsion system (kick stage and interstage). This is a change from our last testimony. The development of the kick stage and interstage, supported by this budget request, will be initiated in FY 1982 and will be continued in FY 1983 leading to a launch in 1986.

Operational Spacecraft

The operational spacecraft include the Voyagers, the Pioneer Venus Orbiter, Pioneers 6-11, the Viking 1 Lander and Landsat -2 and -3. FY 1983 funds for extended Landsat operations will support the continuation of remotely-sensed multispectral and high resolution imagery of the Earth's surface. We currently are reviewing the possibility of terminating all Pioneer spacecraft operations in order to provide adequate support to our ongoing high priority projects.

The Pioneer Venus Orbiter continues to acquire data from the planet Venus. Recently, a comprehensive story has emerged of Venus' cloud system which appears to be a diffuse sulfuric acid (H_2SO_4) smog layer above patchy, condensational H_2SO_4 clouds. There are many new pictures of Venus' cloud motions which have been made into a first movie of Venus' cloud rotation, showing long term circulation. Global atmosphere computer modeling, capable of reproducing atmosphere motions, is now being undertaken using these real data on cloud top dynamics. The radar altimeter map of the Venusian surface, showing continental scale geological features has been completed. The slowly changing orbit of the Pioneer Venus spacecraft also has permitted the interactions of the solar wind with Venus' ionosphere to be mapped through new regions for the study of ionosphere structure and composition.

Pioneers 10 and 11 continue their journey through the outer reaches of the solar system. By the end of 1981, Pioneer 10 was 3.9 billion km from the Sun, closing on the orbit of Neptune. This significant achievement demonstrated that the boundary of the heliosphere is farther from the Sun than had been

previously predicted. Pioneer 11, moving in the opposite direction out of the solar system, was 1.7 billion km from our Sun. Both spacecraft continue to acquire direct measurements of solar and galactic phenomena in interplanetary space.

The Viking Lander-1, renamed the Mutch Memorial Station, in honor of the former Associate Administrator for Space Science, Thomas Mutch, continues to acquire seasonal meteorology and imaging data, as well as engineering information from the surface of Mars. The Lander, the last of four spacecraft which arrived at Mars in 1976, is programmed to acquire data until December 1994.

Halley Comet Watch and Experiments

American scientific expertise is well represented on the European Space Agency's Giotto mission to Comet Halley. Nine of the ten instruments in the payload have U.S. co-investigators with a total of 32 American scientists involved. The U.S. support provides mostly for consultation, limited design effort and some instrument calibration activities by the U.S. scientists. The critical hardware expertise for the Ion Mass Spectrometer resides in the United States and a major section of the instrument is being designed and fabricated here. It is obvious that the input of American scientists is important to the Giotto mission. In addition to participation on instrument teams, American scientists are supporting Giotto in the areas of cometary dust modeling and comet trajectory calculations, both of which are critical areas to the mission. The FY 1983 funding will continue the American scientists' involvement in the Giotto mission.

In FY 1982 organization of the International Halley Comet Watch was initiated. (Fig. 23) A European co-leader of the Watch has been appointed to share management responsibilities with the U.S. leader. A steering group has been established with half non-U.S. membership, including representatives from the Soviet Union and Japan. Several worldwide networks of ground-based observatories are to be established to provide around-the-clock coverage of the comet with wide-angle imaging, spectroscopy, photometry, and other types of observations. Each network will be jointly managed by a U.S. scientist and his non-U.S. counterpart. The FY 1983 funding will be used to initiate the establishment of the international observing networks.

ENVIRONMENTAL OBSERVATIONS

The Environmental Observations Program, as its name implies, is concerned with the Earth's environment. (Fig. 24) The environment begins with the solar wind as it approaches the Earth and encompasses the magnetosphere and its enclosed plasma, the ionosphere, the atmosphere, and the oceans. In the recent NASA reorganization, studies of the magnetosphere, ionosphere, and the solar wind as the driver of the terrestrial environment, were added to this program. The resulting integrated approach to the study of the environment will improve NASA's ability to study and understand comprehensive questions of Sun-Earth relations and climate. All of the phenomena of this program--whether in meteorology, oceanography, aeronomy or plasma physics--are dynamic and ever changing. Thus, we require a program which not only strives to measure present

conditions but works to understand how the environment responds to change, and to forecast its future evolution. The ability to forecast has potential benefits for mankind ranging from weather and storm prediction to providing the scientific basis for environmental and energy-use policy decisions. The elements of the program are at different states of maturity ranging from the well-developed use of space to observe the interplanetary medium, thermosphere, magnetosphere and weather phenomena to the more pioneering efforts to use remote sensing to measure the chemical composition of the upper atmosphere and the state of the global ocean and its circulation.

The program is coordinated to further our understanding of the individual components of the environment and how they interrelate. The goal is ultimately to obtain a comprehensive picture of how the energy from the Sun passes through and interacts with the intervening media to drive the dynamic environment of Earth and of how we influence the evolution of this system.

Active Magnetospheric Particle Tracer Explorers

Energy reaches the Earth in the form of plasma in the solar winds. A crucial area of study is how this plasma is transported and accelerated in the magnetosphere. One step toward finding the answer is the Active Magnetospheric Particle Tracer Explorers (AMPTE), which were initiated in 1981. This mission is a two-spacecraft project being developed in cooperation with the Federal Republic of Germany. The Ion Release Module provided by our German partners will release barium and lithium at several locations inside and outside the magnetosphere. After each release, the Charge Composition Explorer which is being provided by the United States will attempt to detect the released particles from inside the magnetosphere. Throughout FY 1982, design of the spacecraft and the instrument complement will be completed and a critical design review held. During FY 1983, fabrication of the spacecraft and the instrument complement will be completed. Instrument delivery is scheduled for mid- 1983, with launch planned for 1984.

Upper Atmospheric Research Satellite

Below the magnetosphere is the Earth's upper atmosphere, a vital link in the environmental system. Global observations of the chemical composition, dynamics and energetics of the upper atmosphere will be studied by the Upper Atmospheric Research Satellite (UARS) mission. (Fig. 25) These measurements are required before we can adequately understand this region of the environment and make improved projections of the impact of human activity on the stratospheric ozone layer.

We have completed a major step in the UARS experiments activity with the final selection of nine principal investigator research instruments and an operational Stratospheric Backscatter Ultraviolet (SBUV) instrument to be carried on the mission. Ten supporting theoretical investigations also have been chosen to provide numerical modeling tools and data analysis techniques. Integration of these activities into the program will ensure the maximum return from the mission. All of the instruments have completed design definition. We are currently assembling the components necessary to test certain critical areas of instrument design. This will be followed by detailed design for both the instruments and their interface to the spacecraft. The requested funding of $14.0 million will support continuation of these activities in FY 1983.

Earth Radiation Budget Experiment

Many of the essential features of the climate on Earth are determined by the flow of energy in the natural environment. Energy, primarily in the form of radiation from the Sun, is incident on the Earth. Some of that energy is reflected back to space. The remainder is transformed and redistributed by the dynamic processes in the atmosphere and oceans. Detailed understanding of these processes is essential to our ability to comprehend the mechanisms which determine the climate. As a major step in achieving this scientific understanding, the Earth Radiation Budget Experiment (ERBE) will measure how the absorption and emission of energy are distributed over the Earth. (Fig. 26) This measurement will be accomplished using identical earth radiation budget instruments on three different satellites: two polar orbiting NOAA satellites--NOAA-F and G--and a dedicated NASA satellite which will be in a more nearly equatorial orbit. The polar orbiters will provide global coverage but at only one time of day. The lower inclination satellite will provide measurements of change in the radiation budget over the day-night cycle. The dedicated NASA satellite will also carry a Stratospheric Aerosols and Gas Experiment (SAGE) to measure the particle content of the upper atmosphere. Completion and delivery of the instruments will be the major activity in FY 1983, to be supported by the request of $24.0 million. The launch date is under review, pending final determination of the NOAA polar orbiter satellite launch schedule and the availability of space on the STS. Maintenance of current schedules for instrument delivery should, however, minimize the financial impact of a change in the launch schedule.

Nimbus and Operational Satellites

Useful data continue to pour in from the Nimbus-7 satellite. Electric Scanning Microwave Radiometer (ESMR) data from Nimbus-5 are still being obtained and used by the Navy. After two and a half productive years the SAGE satellite has ceased operating, but data reduction will continue into FY 1983. The Environmental Observations program is continuing to support the development, procurement and launch of the NOAA operational weather satellites on a reimbursable basis. However, NASA funding for the Operational Satellite Improvement Program will be phased out after completion of the current development of the operational Stratospheric Backscatter Ultraviolet instrument for the NOAA satellites and other ongoing tasks.

Upper Atmospheric Research

Since 1976, NASA has carried out a program of Upper Atmospheric Research. This program is designed to improve our understanding of the stratosphere and to produce scientific assessments of the probable threat to the ozone layer from chlorofluorocarbons and other residual substances introduced into the atmosphere by human activity. Under this program, laboratory measurements are made of the rates of chemical reactions involving stratospheric constituents. This information is included in predictive models of the upper atmosphere chemistry and is used in the design of new measurement techniques. Observations are made from a variety of suborbital platforms to determine the processes at work in the stratosphere. Satellite measurements provide the global data needed to determine the distribution of ozone and other chemicals

and the circulation of the upper atmosphere. Models are being developed to quantify our understanding of these processes and to make assessments of the ozone layer response to external changes.

The necessity to carry out all of these different activities has been demonstrated by the latest assessment of ozone depletion due to chlorofluorocarbons submitted to the Congress in January. Laboratory measurements have determined new values for the rates of chemical reactions important in controlling ozone destruction in the lower stratosphere. These new values were included in the models and resulted in a new prediction for eventual ozone depletion of 5 to 9 percent. This is substantially less than the previous assessment finding of 15 to 18 percent. The models also were used to calculate the distribution of the various chemical constituents of the stratosphere. These model results were compared with our suborbital measurements and there is greater agreement than in the past. The models can be run retrospectively as well as prospectively to produce a calculated history of ozone concentration. Such calculations have been compared with the satellite data record which now extends over most of the last ten years. The predictions and the data record are now consistent. Lack of such consistency had been raised as an objection to the earlier assessment.

Over the past year, our program in tropospheric air quality has demonstrated the usefulness of geostationary satellite images for detection and tracking of large scale air masses. These pictures reveal the regional and global aspect of air pollution. Theoretical studies have shown the prevalence of long range transport of sulfur oxides from urban areas. These findings show the importance of approaching tropospheric air chemistry from a global perspective. This will be one key element in our continuing program; another element is understanding the global troposphere as a source and sink for trace gases in the upper atmosphere. NASA will continue to explore promising new techniques for sensing tropospheric composition from space and the role that tropospheric chemical composition plays in global ecology.

Weather, Climate & Severe Storms

In the lower atmosphere, the energy from the Sun affects atmospheric dynamics and radiation. This area of research has as its goal the understanding and prediction of the full range of weather phenomena and the climate. (Fig. 27) In the past year, satellite data use has permitted the extension of reliable weather forecasts from three to five days. Analysis of data from the Global Weather Experiment of the international Global Atmospheric Research Program has clarified our understanding of what types of data are necessary for further extensions of forecast capability. In particular, it is now clear that the conventional observing system of ground-based observations and balloons will never be adequate to permit reliable five day forecasts. Tropical data, which are only available from space observations, are needed for long-range forecasts over the United States. Forecasts of the basic weather patterns eight to ten days in advance will require measurements of winds such as those which are now available from cloud tracking in satellite images.

Light detection and ranging (LIDAR) techniques appear to hold great promise for improving the measurement of atmospheric temperature, pressure and winds. (Fig. 28) Ground based experiments have now achieved temperature

accuracies of 1 °C and pressure accuracies of 3 millibars. An aircraft doppler LIDAR instrument for remotely measuring winds has had its initial test flight and was highly successful. In FY 1983, these activities will be extended. In particular, a LIDAR temperature and pressure sounder instrument will be built and tested on aircraft flights.

The Climate program requires data obtained over long time periods to determine the trends in the various aspects of our environment and to determine the causes and predictability. Accurate measurements of this type have begun for solar irradiance using instruments carried on the Nimbus-7 and Solar Maximum Mission spacecraft. These observations have revealed a natural variability in solar output of 0.2% on time scales as short as one week. This finding implies that continuous viewing of the Sun will be required to determine if the solar energy input to the Earth is changing over long periods of time.

The first two years of measurements of stratospheric aerosols have now been added to our climate data base. These measurements continue to come in from the SAM II experiment on Nimbus-7. Efforts are underway to establish the climatology of polar stratospheric clouds and antarctic sea ice. NASA is playing a key role in planning the World Meteorological Organization's International Satellite Cloud Climatology Project. Each of these efforts provides a vital subset of data for the climate data base.

Large numerical models play a central role in all of the scientific investigations in the general area of weather and climate. They are essential for accurate predictions. The growing capability of these models requires a new advanced computer. The High Speed Vector Processor that has been ordered to meet this need starting in FY 1983 and should enable advances in models ranging from the mesoscale of storm systems to those of the global circulation and climate. The facility will also be used by the other programs in environmental observations projects.

Oceans Processes

The last part of the environment which can respond dynamically to the input of energy from space is the global ocean. A key feature of this response appears as the circulation of the oceans. Determining this circulation in full detail has emerged as the central thrust of NASA's efforts in oceanography.

During the past year the oceans program has been restructured following the cancellation of the NOSS project. The community's perceived value of ocean remote sensing, as demonstrated by Seasat and by the Coastal Zone Color Scanner (CZCS) and microwave radiometer on Nimbus-7, continues to grow. Nimbus-7 data is now routinely processed without any backlogs. During the past year, all Seasat data were archived at NOAA. The data contain seasurface temperature to better than 1 °C over selected broad regions; observations of ocean chlorophyll concentration to 30% accuracy over a range of two orders of magnitude in concentration; and, improved measurements of the marine geoid. The altimeter data have also provided a determination of the global variability of the major ocean current systems over the three-month lifetime of Seasat.

In FY 1983, we will continue to take advantage of the existing data sets. An atlas containing overlays of the various Seasat data sets will be published. The utility of these data for studies of polar ice will be assessed. A chlorophyll atlas also will be published. Other efforts will address improving our capability to observe the ocean from space. Since only the surface of the oceans can be observed from space, this necessitates the development of in-situ sensors to reveal the three-dimensional structure of the ocean. Development of such sensors using satellite data relays for gathering this information will be another thrust of the program in the coming year.

The central challenge facing our oceans program now is to develop new space tools to provide the requisite data to improve our understanding of this part of the environment. In addition to an Ocean Topography Experiment (TOPEX) being discussed as a possible dedicated future space mission, the possibility of flying ocean sensors piggy-back on other missions is being examined. This is a low-cost approach for obtaining the needed ocean measurements. This approach appears to be feasible, particularly for the flight of scatterometers and ocean color scanners.

LIFE SCIENCES

In FY 1983 we are requesting $31.7 million for continuation of our Life Sciences Research and Analysis program and $24.0 million for Spacelab flight experiment development.

The resumption of U.S. manned space missions has brought into focus the need for updated medical procedures to cope with the changes that have occurred since the Apollo flights. (Fig. 29) For the first time crew member specialization has required NASA to develop medical standards specific for individual classes of STS crew members. Both STS-1 and STS-2 crews demonstrated good health as they carried out their missions. However, these flights have raised concerns about work-rest cycles, crew time lines, and inflight food and water palatability.

Past U.S. and Soviet experience has shown that nearly 40 percent of all individuals flown in space have experienced motion sickness, and almost all crewmen flown beyond 24 hours have experienced some degree of cardiovascular and muscular deconditioning. On STS-2, the testing of a newly developed lightweight exercise treadmill was initiated. However, due to the shortened mission, the full range of exercise protocols was not tested. Tests will continue on future missions. During FY 1983, newer drugs aimed at decreasing postflight cardiovascular deconditioning will be tested in ground-based simulations of weightlessness.

Among the several important technical advances investigators have made in addressing these problems has been the development of a device for imaging the movements of the heart. Investigators have also recently achieved the first success in visualizing coronary arteries from intravenous angiograms using computer enhancement techniques. The vastly decreased risks of intravenous angiography compared to the conventional injection of a dye into an artery promises to provide an acceptable screening procedure for prospective spaceflight crewmembers and passengers.

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A study of vestibular test procedures and protocols to predict individual susceptibility to space motion sickness was initiated with the first STS flight. The usefulness of biofeedback-like training in suppressing motion sickness symptoms continues to show promise and, based on the observation that it is possible to suppress the vestibular ocular reflex by fixation, the ability to control motion sickness symptoms through this maneuver is also being investigated. The potential benefits of such motion sickness studies to the many people who are susceptible to motion sickness are very high.

The advent of Space Shuttle has brought renewed attention to the development of technology to support human crews in space. Over the past few years, we have developed components and technology for a space suit that can operate with a higher internal atmospheric pressure so that astronauts using it will not have to breathe pure oxygen for several hours before donning it to work in space.

Our laboratory research program is complemented by a Life Sciences Flight Experiments Program which has as its focus investigations that address the safety, well-being, and productivity of man in space, and that can only be carried out in the space environment itself. A secondary goal involves the use of space to further man's understanding of fundamental problems in gravitational biology. Current flight activities include use of small plant growth units on the Shuttle Flight Test missions, seven medical and biological experiments on Spacelab-1, two investigations on Spacelab-2, and a number of important hardware tests on Spacelab-3 which will pave the way to the Spacelab-4 mission discussed later.

With access to the unique space environment, we can now study fundamental mechanisms of physiological changes that occur in both animals and plants in weightlessness. Flight experiment results have shown that our weightless simulation models do indeed mimic bone and cardiovascular changes observed during flight. In addition, research with plant gravity sensors is providing insight into plant growth and control.

In addition to the foregoing research programs which emphasize the health and well being of space crews and the use of the space environment as a laboratory, the Life Sciences program carries out investigations of terrestrial biology. For example, in pursuit of NASA's charter to understand the origin of the universe, ground-based simulations as well as observations and exploration of extraterrestrial environments indicate that the origin and evolution of life is inseparably linked with those processes that shaped the origin and evolution of the universe itself. Studies of ancient rocks have revealed well-preserved microfossils which have pushed back the time for the origin of life on Earth to a point earlier than 3.5 billion years ago. In addition, comparison of these ancient microbes with the characteristics of their modern-day counterparts, an objective of the FY 1983 program, will lead to a better understanding of the composition of the early atmosphere with which these organisms interacted.

SPACELAB FLIGHT

The first Shuttle flights have opened the prospect of an era of new capabilities in our space science and applications program. In particular the

Shuttle/Spacelab system offers to the space science, applications and technology disciplines the unique capabilities of large payload capacity; return of flight experiment hardware, film, materials processing samples, and life sciences specimens; active manned operations; and repetitive access to space. An active Spacelab utilization program is being implemented to take maximum advantage of these capabilities. (Fig. 30) Programs now underway span an impressive spectrum of research, as even a brief summary demonstrates.

The flight of OSTA-1 in 1981 amply demonstrated the Shuttle's capability for scientific and applications research. OSTA-1 was the first step in our attempt to learn how to take advantage of the Space Shuttle. Scientific data were returned, and experience was gained in the design, construction and integration of a scientific payload. When the flight was shortened, the team of OSTA-1 investigators and flight controllers demonstrated their capability to replan the mission quickly and effectively in order to accomplish the mission objectives.

The next flight of the Space Shuttle will also carry a scientific payload. The OSS-1 payload, scheduled for an early 1982 launch, is a single pallet containing nine scientific instruments which will be used to carry out science investigations and to evaluate the effects of the Shuttle on scientific measurements. Plasma physics experiments using the remote manipulator arm will map the electromagnetic fields in and around the Orbiter. Additional investigations in solar physics, planetary physics, astronomy and life sciences will be performed. The payload is in the final stages of flight preparation.

We continue to make substantial progress on other missions as well. Spacelab 1, a cooperative mission between NASA and the European Space Agency (ESA), will be the first flight of the module-plus-pallet configuration of Spacelab. There are eighty-one individual investigations on the mission, covering the discipline areas of plasma physics, solar physics, astronomy, atmospheric physics, Earth observations, material sciences and life sciences. Integration of the ESA portion of the science payload is almost complete with delivery to the United States scheduled in mid-1982. The NASA portion of the payload is now being delivered. Launch is planned for late 1983.

We are in the final stages of establishing our Spacelab Ground Processing Operations support facilities at the Kennedy Space Center (KSC). The processing capability includes modifications to the operations and checkout building and the development of ground test and support equipment. The processing, equipment, software and procedures are on schedule to support the ground processing of Spacelab 1, which is to begin in March 1982.

Additional missions are also in various stages of development. For instance, OSTA-2, a cooperative materials processing mission with the Federal Republic of Germany, is tentatively scheduled for flight in early 1983. It will be the first flight of the Materials Experiment Assembly, with reflight planned for late 1983.

The OSTA-3 payload is planned to be flown as part of the STS-16 mission in 1984. The OSTA-3 payload will include the Large Format Camera and its associated Attitude Reference System for acquiring high resolution mapping

quality photographs with black and white, color and color infrared film. In addition, we are considering flying an upgraded version of the highly-successful Shuttle Imaging Radar to acquire imagery for a broader range of investigations in geology, agriculture, hydrology, and ocean ice.

Spacelab 2, the second dedicated Spacelab mission, will carry out scientific investigations in the areas of solar physics, high energy astrophysics, infrared astronomy, plasma physics, life sciences, and space technology. Twelve instruments, two of which are from the United Kingdom, will be flown. The mission, which is currently scheduled for a late November 1984 launch, will be a verification flight of the all-pallet/Igloo Spacelab configuration with the ESA-developed Instrument Pointing System (IPS) flying for the first time. Assembly and test for most of the Spacelab 2 instruments will be completed in 1982.

Spacelab 3 will be the third dedicated mission and will employ the module as a manned laboratory for performing experiments in the disciplines of materials processing, life sciences and technology. Low gravity investigations will be emphasized. Work on the Fluid Experiments Systems/Vapor Crystal Growth (FES/VCG) will continue through ground rack integration and then be taken to Marshall Space Flight Center for final testing and integration. Two instruments to be used for environmental observations and cosmic ray measurements will be mounted on a special structure inside the payload bay. Initial design of the integrated payload was completed in 1981. Final design is expected to be completed in 1982, leading to a launch in 1984.

Spacelab 4 will be the first life sciences dedicated mission and is planned for launch in late 1985. Twenty-five investigations have been tentatively selected as the payload for this mission. The scientific objective of this payload is the study of the acute effects of weightless exposure on living systems. There is a general emphasis on the gathering of more extensive data on previously observed physiological changes in humans and on developing animal models of the major human changes associated with weightlessness.

The OSS-3 pallet, now in development for flight in 1985, will represent our first major step in a shuttle based ultraviolet astronomy program. These instruments, which have been carefully selected to complement Space Telescope capabilities, will observe various astronomical objects, such as intrinsically polarized stars, quasars, active nuclei of galaxies, and globular clusters. In late 1985 through early 1986, Halley's Comet will make one of its once-in-a-lifetime appearances. To take advantage of this event, plans are being made to observe the comet in ultraviolet wavelengths from the Space Shuttle using the cluster of telescopes currently under development for the OSS-3 mission.

In addition to the smaller investigator-developed instruments, the Solar Optical Telescope (SOT) will be developed. The SOT is planned to be a 1.2-meter aperture telescope intended to be carried on several Spacelab flights in the late 1980's for ultra-high resolution studies of the Sun at near infrared, visible and ultraviolet wavelengths. Solar features as small as 80 kilometers across will be observed routinely with this telescope, a performance five times better than the best ground-based solar telescopes can achieve even

under rare, ideal observing conditions. SOT will study time-varying phenomena of small solar features such as the fine structures of the chromosphere, magnetic flux ropes, spicules and flare sites. The focal plane instruments which we plan to fly on SOT were selected for definition in September of 1981. They are a combination spectrograph and tunable filter system and a wide-angle film imaging system. The spectrograph will cover both the visible and ultraviolet regions of the solar spectrum, permitting accurate measurements of magnetic field strengths, and permitting us to detect the vertical motions of the plasma of the Sun's atmosphere over a wide range of temperature. The imaging instruments will complement this capability by providing two-dimensional pictures of the structures of the Sun's surface with velocity and magnetic field information.

MATERIALS PROCESSING

The Materials Processing in Space (MPS) program seeks to exploit the low-gravity environment of near Earth orbit to ascertain and understand the role of gravity in materials processing, and where possible, to demonstrate the production of improved materials which have high technological utility. (Fig. 31) Major emphasis continues in establishing a sound scientific foundation through our Applied Research and Data Analysis program for these activities. Materials Experiment Operations, which will continue to provide ground based, short term, low gravity, experimental opportunities, will be augmented this year by our first opportunities for experimentation aboard STS. The Monodisperse Latex Reactor (MLR), designed to produce highly uniform latex spheres, is a payload which will be mounted in the Shuttle crew cabin. The MLR is scheduled for flight on the third, fourth, fifth and sixth Shuttle flights.

The ground and airborne low-g based facilities continue to provide not only the necessary testing opportunities for future STS experiments, but new and important scientific information as well. Last year, drop tube experiments showed that a compound of niobium and germanium, known for its superconducting properties, could be supercooled by 500°C below its normal melting point during free fall, indicating a potential for the production of new, metastable materials by this method. Studies utilizing the low-g parabolic flight of a KC 135 aircraft have also shown that decreasing gravity leads to increases in the grain size of castings, indicating the role of gravity-driven convective flow in establishing the microstructure of materials.

Space Processing Application Rocket (SPAR) experiments flown in 1981 showed that an eutectic (minimum melting point) composition of manganese and bismuth has substantially different microstructure when solidified at low-g compared to that at 1-g. This result, unexpected and still unexplained by conventional theory, is another example of how important contributions can be made to materials science by low-g research.

The McDonnell-Douglas (MDAC) Joint Endeavor Agreement (JEA) for the separation of biologicals in low-g has proceeded through design and testing of hardware (a MDAC funded effort) and will have the first of its six planned Shuttle Mid-deck flights on STS-4 during 1982. A new JEA has been signed with the GTI Corporation which will provide small samples solidified in low gravity

to university and industrial researchers. Negotiations for the third MPS JEA proposed by Microgravity Research Associates Corporation are expected in early 1982. The first Technical Exchange Agreement (TEA) was signed in August 1981, with John Deere and Company and will provide cooperative NASA/Industry research efforts in the study of convection efforts in cast iron microstructure. Two additional TEA's with Du Pont Corporation and INCO Research and Development, were signed in January 1982.

COMMUNICATIONS

NASA has continued efforts to re-establish its leadership role in the development of technology for future satellite communications systems. (Fig. 32) The currently allocated spectrum bands for satellite use are becoming saturated under the demand for commercial systems. NASA, in a joint program with U.S. industry, is developing technology designed to directly alleviate the inevitable saturation of the currently used orbit and spectrum which will occur by the early 1990's. We are currently investigating the best way to conduct a system level test and evaluation mission which will meet these objectives and regain U.S. pre-eminence in this important industry. The Search and Rescue Satellite Program is progressing satisfactorily toward a first launch in 1982. Studies that explore the uses of technology for space communications have shown that there will be many areas of application for public benefit.

Applied Research and Data Analysis

In communications technology development NASA has awarded several multi-year contracts with U.S. industry to establish a strong technology base for the future use of new frequency bands. More specifically, the development of proof-of-concept hardware of several major communication subsystems has been undertaken. These systems include multi-beam antennas, high capacity on-board switches, advanced on-board processors and other radio frequency components.

Search and Rescue Mission

The Search and Rescue Mission is being conducted as a multilateral demonstration program by Canada, France and the United States, using special instrumentation packages on board the U.S. NOAA series of meteorological spacecraft. The program will demonstrate improvements in the ability to detect, and then precisely locate, emergency signals transmitted from aircraft and ships in distress. The Soviet Union is collaborating in the program and plans to launch at least two COSPAS satellites compatible with the Canadian, French, and U.S. SARSAT system. In addition, to these major participants, Norway, Japan and the United Kingdom are expected to participate in the program as investigators by deploying test transmitters and ground stations compatible with the satellite.

All elements of the system are expected to be ready for the launch of the first two satellites in the series -- NOAA-E and COSPAS I — by mid-1982.

The $3.7 million requested in FY 1983 will permit an analysis of the overall effectiveness of the system including its location accuracy and its overall impact in improving search and rescue operations. In addition, the FY

1983 funds will be used to complete the integration and test of the search and rescue instruments on the NOAA-F and G spacecraft and to make provision to accommodate Search and Rescue instruments on NOAA spacecraft H-J.

Technical Consultation and Support Studies

Major emphasis during FY 1983 will include continued activities leading towards the development of U.S. strategies, positions, and technologies needed to support U.S. positions at the three International Telecommunications Union (ITU) Regional and World Administrative Radio conferences scheduled for the 1983-1987 time frame. Decisions reached at these conferences will directly affect our country's access to the geostationary orbit and radio spectrum.

Experiment Coordination and Mission Support

This element of the Communications Program provides continued support of the Applications Technology Satellites, (ATS-1, -3, and -5), and the appropriate documentation and archiving of the wide range of user experiments and demonstrations in the application of satellite communications. Nearly 400 communications experiments using the ATS series and the Communications Technology Satellite (CTS) have been conducted successfully, both nationally and internationally, during the extended lifetimes of these satellites. The FY 1983 budget request of $1.0 million will cover the completion of ATS-1, -3, and -5 operations.

SUPPORTING PROGRAMS

Our Suborbital and our Research and Analysis programs provide the foundation for our total scientific program. Research and Analysis activities fall into five general areas: extended data analysis, laboratory investigations, complementary ground-based observations, theoretical studies and instrument definition and development. Past missions have accumulated a wealth of data on a wide range of natural phenomena. In general, the data analysis during the operational lifetime of a mission cannot fully extract all the knowledge to be gained from the data. Extended data analysis continues to capitalize on the valuable data sets after missions are complete. Ground-based observations provide the complementary and ground-truth data needed to fully interpret the space observations. Laboratory investigations provide additional information on the physical process being observed, and theoretical studies provide a broad perspective on the observed phenomena. Our future missions build on the bases provided by past missions and supporting programs. Theoretical studies lead to new theories that must be tested and suggest new observations to test old theories. Instrument definition and development, which provides the technological base for our research missions, is a multifaceted activity which is carried out in the laboratory, on suborbital flights and on the Shuttle. In addition, as has been mentioned earlier, our life sciences program maintains a vigorous program of medical studies to understand the problems related to the health and well being of humans in space. These supporting programs provide a significant measure of the basic research support to the university, government and industrial scientific researchers who make up the heart of the space science and applications program.

Our suborbital program has seen considerable recent activity, with numerous sounding rocket, balloon and aircraft flights. FY 1981 saw the first flight of the Black Brant X rocket from Wallops Island, Virginia. This high performance, three stage vehicle was developed as a joint effort among United States, Canadian, and Swedish research institutions and is capable of high altitudes, extended distances, and high accuracy.

Over recent years, NASA has become the major user of balloons for scientific research. During this time, the National Science Foundation has been supporting the balloon operations program through its National Scientific Balloon Facility (NSBF) in Palestine, Texas. Discussions on a potential transfer of responsibility are continuing and we are considering the possibility of NASA taking responsibility for the operation of the NSBF sometime in FY 1983.

To enhance the science return from its space activities, NASA maintains an active scientific research aircraft program. Flights of U-2's and the ER-2 aircraft will continue from the Ames Research Center in support of the Airborne Instrument Research Program which concentrates on remote sensing of the Earth and its atmosphere. The Kuiper Airborne Observatory, a C-141 supporting the infrared astronomy program, will fly approximately 65 times during the coming year.

Each area of the Research and Analysis program has had significant accomplishments in the previous year, and continuing activity is planned for FY 1983. In extended data analysis, for instance, efforts will continue on the Viking Lander data although at a somewhat slower pace than previously planned. Data collected and analyzed through three Martian autumn-winter-spring cycles show variations of pressure and illumination at the landing site which lead to the conclusion that local dust storms during the winter months produced movement of the dust which modulates the seasonal CO_2 cycle.

In the area of laboratory investigations, a broad based research effort continues in life sciences, searching for mechanisms underlying the cardiovascular changes observed in simulated spaceflight. Laboratory studies of cometary phenomena are being conducted to prepare for the ground and spacecraft observations of Comet Halley in 1986. Measurements also are being made of the rates of chemical reactions involving stratospheric constituents for use in predictive models of the upper atmosphere chemistry and in the design of new measurement techniques.

In the ground-based/collateral data study area, efforts continue in planetary astronomy, where recent results include studies of Jupiter's ring and of volcanoes on its satellite Io. The ring around Jupiter discovered by Voyager I has now been observed directly from the Earth. It also has been determined that, unlike the icy rings of Saturn, Jupiter's ring consists of rocky material. The volcanoes on Io, also discovered by Voyager, can now be monitored with Earth-based telescopes. Such follow-up studies of planetary spacecraft results will be continued.

In technique testing, joint tests are conducted with major resource and commodity decision-makers in representative applications. Technique tests of irrigated lands for assessment of water management and monitoring of insect defoliation of hardwood forests will be completed in FY 1982, while utilization

of soils data in crop classification and mapping of irrigated croplands in western aquifers is continuing. Several new technique tests will be pursued in FY 1982 and FY 1983 with emphasis on testing Thematic Mapper (Simulator) techniques for use in hydrology, coastal wetlands, forestry, facility siting, and agribusiness. These tests will help determine the utility of remote sensing techniques in real world applications and serve to guide our future research and development program.

The tropospheric air quality program has carried out ground-based measurements of the atmospheric concentration of methane, indicating an increase that may have climate implications. These data are just one part of the study of tropospheric air chemistry.

In the theoretical study area, several activities are continuing. The Solar Terrestrial Theory Program is a cohesive effort by groups of theoreticians and computational physicists to study the processes that are important to solar terrestrial relations. A number of significant developments have been achieved including a new contribution to the theory of heat flow in the Earth's polar wind and its effect on ionosphere-magnetosphere energy exchange. Chemical modeling is an important component of the planetary atmospheres program, and the Voyager discovery of hydrogen cyanide molecules on Titan has further stimulated efforts. Hydrogen cyanide is a key compound in the synthesis of amino acids, believed to be the forerunner of living organisms. It had previously been observed in interstellar space but not in planetary atmospheres. Studies of Titan's complex hydrocarbon chemistry are being undertaken to identify the formation processes for the molecules believed to be responsible for Titan's haze layer.

Instrument development continues in many areas. In astrophysics, for instance, we are working on X-ray mirror technology with the aim of increasing spatial resolution and collecting area. These mirrors will have wide application in astronomy and solar physics. Effort is also underway directed toward developing new detectors for X-ray, cosmic-ray and gamma-ray astronomy.

In data processing technologies, the Information Systems Office supports a wide variety of multi-disciplinary OSSA programs. The objective of the Information Systems Program is to evolve data system capabilities by applying a broad range of computer technologies to research projects and flight missions, resulting in improved access to and utilization of higher quality data. (Fig. 39) Space science and earth applications missions such as Spacelab, Landsat, and Space Telescope will be generating increasing volumes of data at greater rates, with increased pressures from users for more efficient and cost effective yet sophisticated processing capabilities. The FY 1983 program will begin to provide the foundation for the timely development of information systems capabilities and concepts to meet initial needs of future programs, thereby reducing ground data system development risks.

These brief examples are intended to show the scope of the supporting program, and demonstrate how the activities provide essential support for past, present and future missions. The number of individual tasks is much too large to do more than scratch the surface of the activity; it would be impossible to review the whole program fairly here. However, each task, like a piece in a

jigsaw puzzle, plays an essential role in the effort to carry out our space science and applications program. As mentioned earlier, we are reviewing our priorities within the requested budget levels to determine if some economics are possible.

FUTURE PROGRAMS

So far, I have described to you programs and activities that are currently underway. The Office of Space Science and Applications also has a planning activity which looks toward future opportunities to build upon previous results or to initiate new lines of research. I would like to conclude my statement by indicating a few of the possibilities. (Fig. 33 and 34)

With the launch of the first orbiting X-ray telescopes, it became clear that we knew very little about the many violent, explosive regions in the universe. The results of HEAO-2 have shown the value of yet higher resolution imaging X-ray telescopes to investigate the nature and evolution of the forces that make stars, galaxies and quasars. During the past several years we have been defining the Advanced X-Ray Astrophysics Facility (AXAF) as a potential candidate future mission which is a free flying X-ray observatory that will be Shuttle-launched, serviceable in orbit, and retrievable. Our studies show that AXAF can be made 100 times more sensitive than HEAO-2. Current work is concentrating on the development of the X-ray mirror technology which is at the heart of this mission.

The Gravity Probe B (GP-B) mission will place extremely precise gyroscopes into a polar orbit to see if the spin of the earth can change the direction the gyros point. According to general relativity, the rotation of the Earth literally drags space around with it producing a small extra motion of gyroscopes which is not predicted by Newtonian physics. In the last 20 years we have succeeded in developing the technology capable of sensing this effect, which will provide a fundamentally new test of Einstein's General Theory of Relativity. GP-B has started definition efforts for the systems and subsystems of the spacecraft and instrument. In FY 1982 and 1983, the definition studies will be completed, and a final breadboard demonstration of high technology items will be accomplished. At the end of these activities, the mission will be considered for a new start.

The Extreme Ultraviolet Explorer (EUVE) will survey the sky in a part of the electromagnetic spectrum that heretofore has remained relatively unexplored. Although we knew from theory that stars should radiate copiously in the extreme ultraviolet, it was not until the Apollo-Soyuz mission that we discovered that the interstellar medium around the Sun was dilute enough to let us see several hundred light years around the Sun. In FY 1983, mission definition and design will be continued.

In addition to major observatories like AXAF, more specialized missions designed to study specific problems with specialized instruments are needed in X-ray astronomy. The X-Ray Timing Explorer (XTE) is planned to carry out extensive studies of the temporal variations in X-ray sources over a broad energy range. Such observations will provide essential new data on the internal constitution of white dwarf and neutron stars, on the physical

processes occurring in the vicinity of black holes, and on the swirling disks of hot gas which surround these objects. FY 1983 funds will be used to initiate early definition studies of the spacecraft and instrument complement.

The Shuttle Infrared Telescope Facility (SIRTF) is designed to study the cool regions of space, such as dust and gas clouds where stars are forming, and the planets, asteroids and comets of our solar system. It will be at least a thousand times more sensitive than any ground-based telescope, and a hundred times more sensitive than other space systems. SIRTF's unique capabilities will be key to major advances in diverse fields of astronomy. Initiation of a Phase B study is being considered for FY 1983.

An understanding of our twin sister planet, Venus, remains essential to an understanding of Earth itself as well as being necessary for understanding the history of the inner solar system. The agency will continue to look at options for a Venus mission as part of its future program planning.

An ongoing study is underway to provide a long-term mission strategy for the exploration of the entire solar system, including the inner planets, outer planets, and small bodies. The small bodies are relatively primitive objects. Therefore, they offer exceptional promise in helping us understand the original state of the solar system; accordingly, the small bodies will be given high priority in our mission planning. By the fall of this year, we expect this study to be finished thereby providing a long-term, balanced mission strategy and an affordable implementation approach. As a result, we can anticipate that we will again be in a position to make significant progress across a broad front, toward our ambitious goal of understanding the origin and evolution of the solar system and our own planet.

Turning closer to home, the next major step in the study of the Earth's magnetosphere will be to study the global flow of energy and matter in the Earth's space environment, its energization and it storage. In order to do this, we are planning the Origin of Plasmas in Earth's Neighborhood (OPEN) program as a candidate new thrust in our study of Sun-Earth relationships. In its current concept OPEN consists of four spacecraft making closely coordinated measurements of the major regions of the Earth's environment where energy is known to be stored or transported: the solar wind, the magnetosphere, the ionosphere and the tail of the Earth's magnetic field. We have recently selected a set of investigations for definition and will be undertaking definition studies of both instruments and spacecraft during the next year.

We also are planning to use Shuttle/Spacelab to carry out a new generation of "active" experiments in space plasma physics. Controlled experiments to examine the reaction of the Earth's magnetosphere to the introduction of energetic particles will be conducted using particle beam accelerators and electromagnetic wave injection mechanisms.

As has been discussed earlier, a fundamental problem in oceanography is the determination of the direction and speed of the water flow of the Ocean Circulation. The Global Ocean Topography Experiment (TOPEX) is planned to use a spacecraft borne radar altimeter to measure the height of the sea surface, from which the global circulation of the oceans can be determined for the first

time. The TOPEX Science Working group has determined the scientific requirements of such a mission and published its findings in 1981. A conceptual design study for such a space mission has also been completed and indicates that the idea is feasible. Future activities will involve a study of options for a candidate TOPEX mission.

We also continue to study new techniques to investigate surface geology and to gain new insights on the Earth's interior. The Shuttle Active Microwave Experiment (SAMEX), is planned to be a major evolutionary advancement in Synthetic Aperture Radar instrumentation. Among the scientific objectives of SAMEX is obtaining a better understanding of the imaging radar signature of different lithologic units, structural features, and surface covers. The experience gained from SAMEX imagery of the Earth will be of considerable value in planning future planetary radar imaging missions.

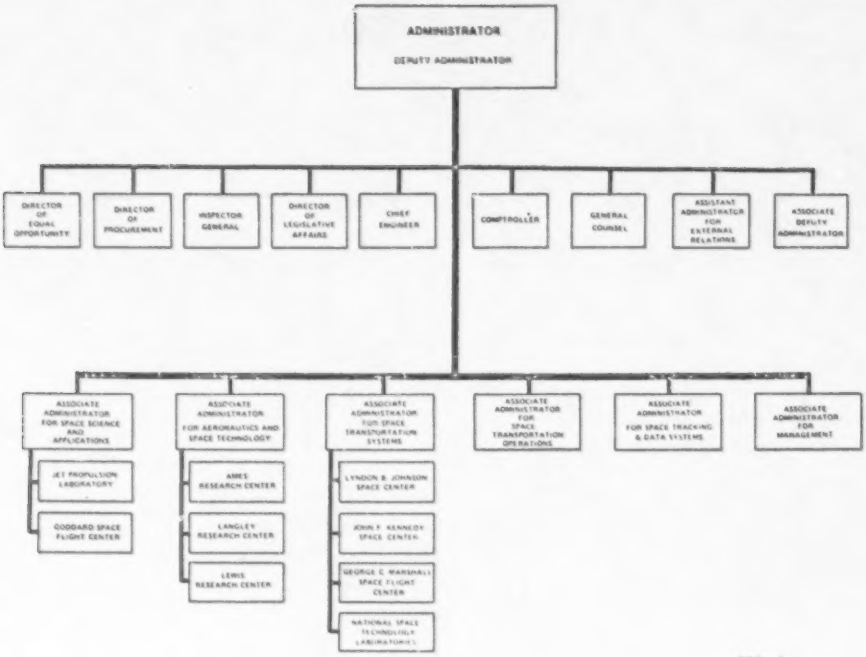
The GRAVSAT/MAGSAT mission is being planned to make more quantitative interpretations of the Earth's gravity field to advance our understanding of the theory of global plate tectonics and to continue studies of the decay and secular variation of the Earth's magnetic field. In its current concept, the mission consists of two spacecraft which follow one another in orbit at an altitude of 160 km. Variations in the Earth's gravity field will be studied by the results of satellite-to-satellite ranging. The mission concept has been developed over the past two years, and the conceptual feasibility of critical elements has been demonstrated through computer simulations and laboratory tests.

The Multispectral Linear Array (MLA) activity is a development effort leading to an advanced, high performance sensor applicable to advanced missions for fundamental research in remote sensing. The emphasis in the current program is on developing an all solid state MLA sensor incorporating a new generation of detector materials, visible and shortwave infrared (SWIR) multispectral linear focal plane arrays, on-board signal processing and ground data processing concepts. The FY 1983 MLA activities will continue the technology development, instrument definition and long term development of an innovative and versatile imaging spectrometer sensor.

In addition to individual missions, we have been studying for some time new approaches to carrying out investigations in space. For example, a space platform might be a logical first step toward achieving a permanent presence in space. Such a platform could be a Shuttle-tended spacecraft with on-orbit replaceable propulsion and subsystem modules, which would provide utilities, stabilization and accessibility for a wide variety of temporarily emplaced payloads. Many of the payloads on an early space platform mission could be derived from those developed for the Spacelab payload program as a logical extension for those investigations requiring longer duration flights. As a space platform utilization program matures, payloads designed specifically to exploit its capability could be developed.

Finally, as indicated at the beginning of my statement, the combination of the Science and Applications program has given us a new opportunity to study the Earth from a planetary perspective and, in particular, to study the influence of life itself on the planet. For the first time, we are now able to monitor, on a global scale, the interaction of the Earth's biota with all elements of the biosphere-the land, oceans and atmosphere. Such studies should provide answers to fundamental questions about how biology modulates the cycling of key elements and molecules between these components, and thereby allow better understanding of the stability of the ecosystem as a whole, as well as predictions regarding the short and long term effects of perturbations, both natural and life-related. Our ultimate objective would be to understand life on Earth as a planetary phenomenon, a phenomenon whose origin, evolution and current state is inseparable from the origin, evolution and current state of the planet itself.

As is evident, there are rich possibilities for major future advances in our understanding of the universe, the solar system, the Sun and the Sun-Earth connection, and the Earth itself.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COMPTROLLER
GENERAL COUNSEL
ASSISTANT ADMINISTRATOR FOR EXTERNAL RELATIONS
ASSOCIATE DEPUTY ADMINISTRATOR
ASSOCIATE ADMINISTRATOR FOR SPACE SCIENCE AND APPLICATIONS
JET PROPULSION LABORATORY
GODDARD SPACE FLIGHT CENTER
ASSOCIATE ADMINISTRATOR FOR AERONAUTICS AND SPACE TECHNOLOGY
AMES RESEARCH CENTER
LANGLEY RESEARCH CENTER
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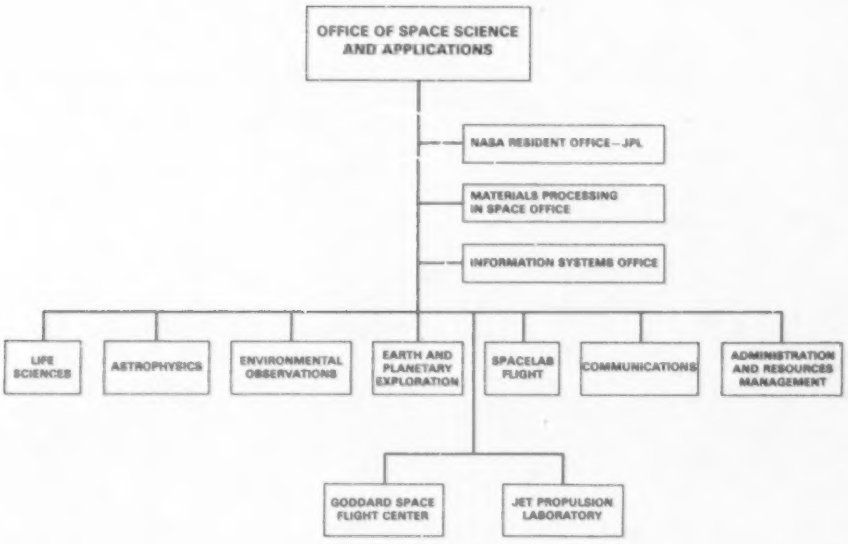
ASSOCIATE ADMINISTRATOR FOR SPACE TRANSPORTATION OPERATIONS
ASSOCIATE ADMINISTRATOR FOR SPACE TRACKING & DATA SYSTEMS
ASSOCIATE ADMINISTRATOR FOR MANAGEMENT

FIG. 1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ENVIRONMENTAL OBSERVATIONS
EARTH AND PLANETARY EXPLORATION
SPACELAB FLIGHT
COMMUNICATIONS
ADMINISTRATION AND RESOURCES MANAGEMENT
GODDARD SPACE FLIGHT CENTER
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FIG. 2

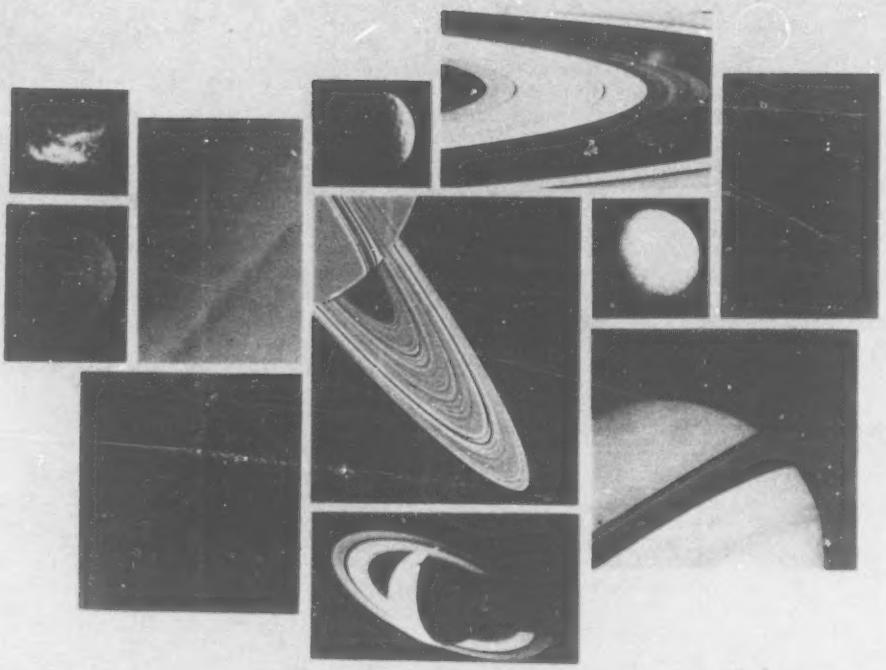
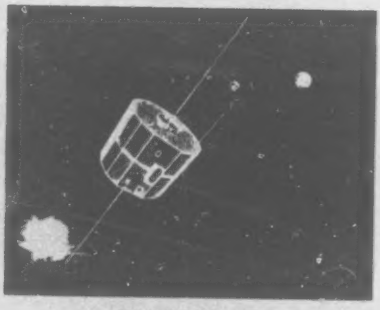


FIG. 3

DYNAMICS EXPLORER

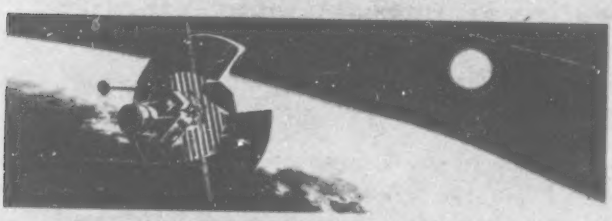


SPACECRAFT

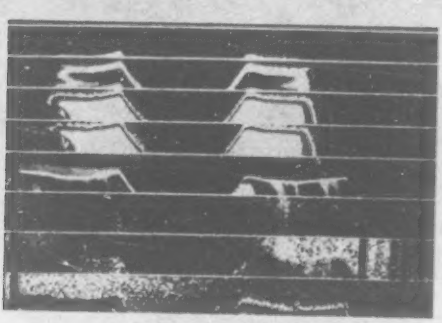
AURORA

FIG. 4

SOLAR MESOSPHERE EXPLORER



SME SPACECRAFT & SUN

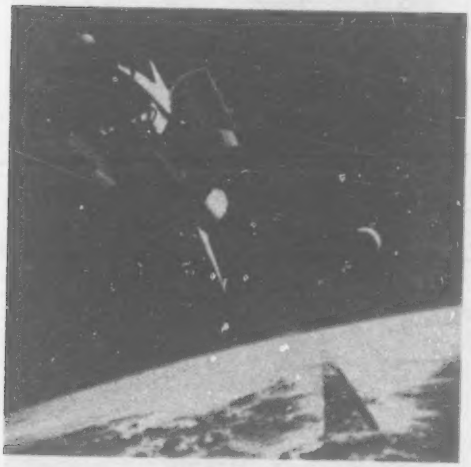


OZONE PROFILE

FIG. 5

OSTA-1 RESULTS

SHUTTLE IMAGING RADAR-A (SIR-A)



PERFORMANCE:

- 10 MILLION SQUARE KILOMETERS COVERAGE
- WIDE VARIETY OF GEOLOGIC FEATURES IMAGED
- RESOLUTION 36-40 METERS

FIG. 6

SIR-A IMAGE
OIL RIGS AND VESSELS (PERSIAN GULF)

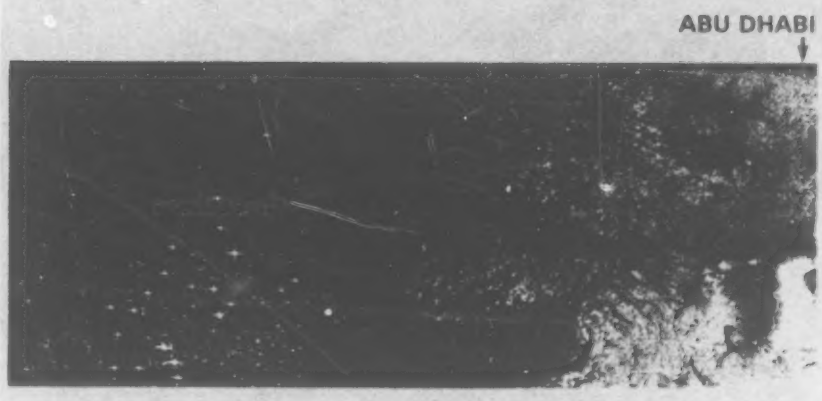


FIG. 7

OFFICE OF SPACE SCIENCE AND APPLICATIONS
FY 1983 BUDGET REQUEST
(DOLLARS IN MILLIONS)

	FY 1982		FY 1983
	MARCH AMENDMENT	OPERATING PLAN	REQUEST
SPACE APPLICATIONS TOTAL	372.9	325.8	316.3
RESOURCE OBSERVATIONS			
LANDSAT-D	83.9	83.9	61.7
EXTENDED MISSION OPERATIONS	2.8	2.8	1.8
SHUTTLE/SPACELAB PAYLOAD DEVELOPMENT	2.0	3.3	2.8
GEODYNAMICS	30.9	22.9	28.2
AgRISTARS	23.1	14.0	15.0
APPLIED RESEARCH AND DATA ANALYSIS	22.7	19.5	24.7
SUBTOTAL	165.4	146.4	132.2
ENVIRONMENTAL OBSERVATIONS			
UPPER ATMOSPHERIC REACH PROGRAM	15.0	13.0	16.5
APPLIED RESEARCH AND DATA ANALYSIS	56.5	47.0	54.7
SHUTTLE/SPACELAB PAYLOAD DEVELOPMENT	4.1	4.1	3.7
OPERATIONAL SATELLITE IMPROVEMENT PROGRAM	11.8	6.0	6.0
EARTH RADIATION BUDGET EXPERIMENT	24.0	24.0	24.0
EXTENDED MISSION OPERATION	11.4	11.4	10.0
UPPER ATMOSPHERIC RESEARCH SATELLITE EXPERIMENT AND MISSION DEFINITION	5.0	6.0	14.0
HALOGEN OCCULTATION EXPERIMENT	7.5	5.0	—
SUBTOTAL	135.3	116.5	128.9
APPLICATIONS SYSTEMS	14.2	13.2	11.7
TECHNOLOGY TRANSFER			
USER REQUIREMENTS AND SUPPORT ACTIVITIES	—	3.0	—
REGIONAL REMOTE SENSING PROGRAM	—	2.0	—
SUBTOTAL	—	5.0	—
MATERIALS PROCESSING IN SPACE			
APPLIED RESEARCH AND DATA ANALYSIS	14.0	12.0	13.1
SHUTTLE/SPACELAB PAYLOAD DEVELOPMENT	7.6	8.8	3.3
MATERIAL EXPERIMENT OPERATIONS	6.1	3.0	7.2
SUBTOTAL	27.1	23.8	23.6

FIG. 9

OFFICE OF SPACE SCIENCE AND APPLICATIONS
FY 1983 BUDGET REQUEST (CONTINUED)
(DOLLARS IN MILLIONS)

	FY 1982		FY 1983
	MARCH AMENDMENT	OPERATING PLAN	REQUEST
COMMUNICATIONS AND INFORMATION SYSTEMS			
APPLIED RESEARCH AND DATA ANALYSIS	15.4	10.0	8.1
SEARCH AND RESCUE	1.3	2.3	3.7
TECHNICAL CONSULTATION AND SUPPORT	2.6	2.6	2.6
EXPERIMENT COORDINATION AND OPER. SUPPORT	1.0	1.0	1.0
INFORMATION SYSTEMS	10.0	5.0	7.5
SUBTOTAL	30.3	20.9	18.9
PHYSICS AND ASTRONOMY – TOTAL	325.4	323.5	471.7
SPACE TELESCOPE DEVELOPMENT	119.5	121.5	137.5
INTERNATIONAL SOLAR POLAR MISSION DEV.	5.0	5.0	21.0
GAMMA RAY OBSERVATORY DEVELOPMENT	8.0	8.0	34.5
SHUTTLE/SPACELAB PAYLOAD DEVELOPMENT AND MISSION MANAGEMENT	35.0	40.0	81.4
EXPLORER DEVELOPMENT	36.0	33.3	34.3
MISSION OPERATIONS AND DATA ANALYSIS	47.0	50.0	86.6
RESEARCH AND ANALYSIS	38.9	32.9	38.2
SUBORBITAL PROGRAMS	35.5	32.8	38.2
PLANETARY EXPLORATION – TOTAL	215.3	208.0	184.6
GALILEO DEVELOPMENT	168.8	139.0	92.6
VENUS ORBITING IMAGING RADAR	10.0	–	–
MISSION OPERATIONS AND DATA ANALYSIS	45.8	38.3	28.5
RESEARCH AND ANALYSIS	51.5	46.7	35.5
LIFE SCIENCES – TOTAL	43.5	39.6	55.7
SHUTTLE/SPACELAB PAYLOAD DEVELOPMENT	14.0	14.0	24.0
RESEARCH AND ANALYSIS	29.5	25.5	31.7
TOTAL OFFICE OF SPACE SCIENCE AND APPLICATIONS	957.1	993.8	998.3

FIG. 10

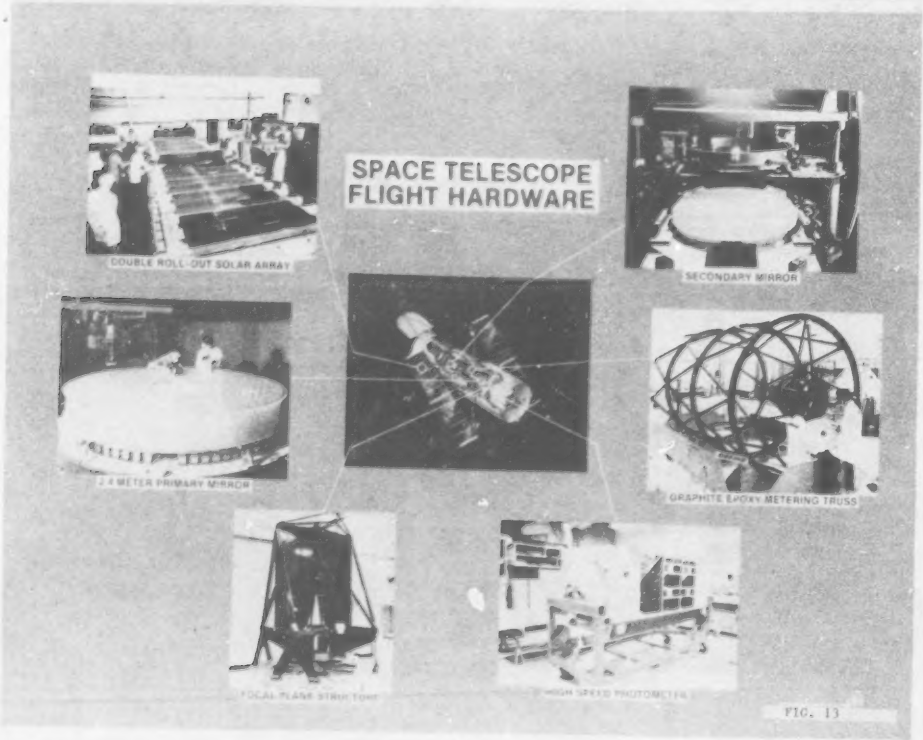
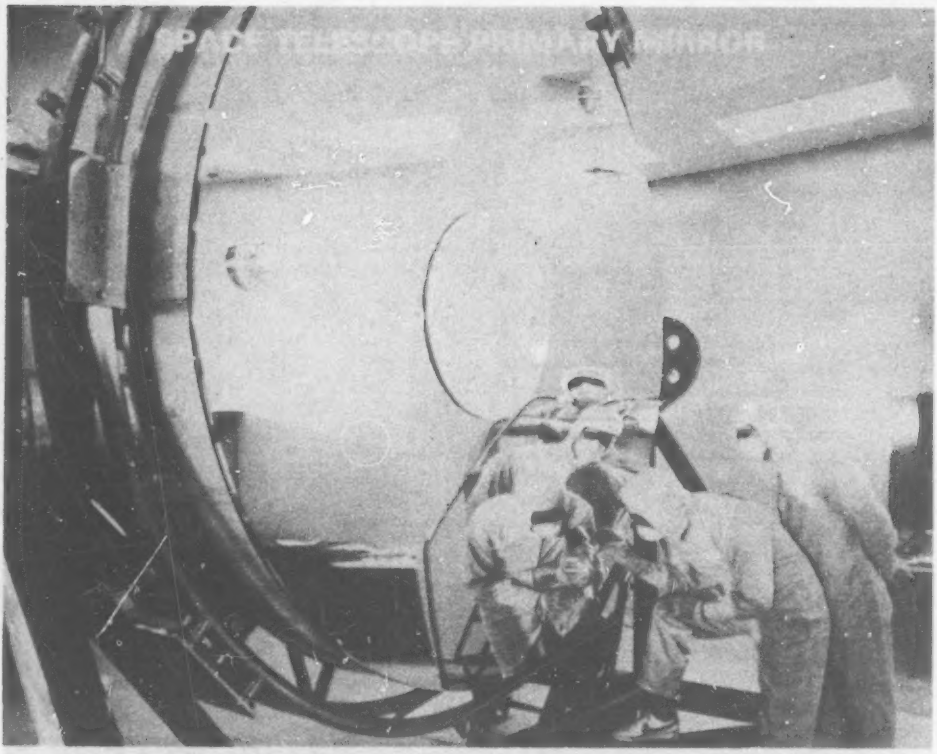
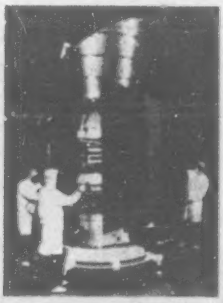


FIG. 13



INFRARED ASTRONOMY SATELLITE

STAR FORMING REGIONS



PLANETS AND ASTEROIDS

GALAXIES AND QUASARS

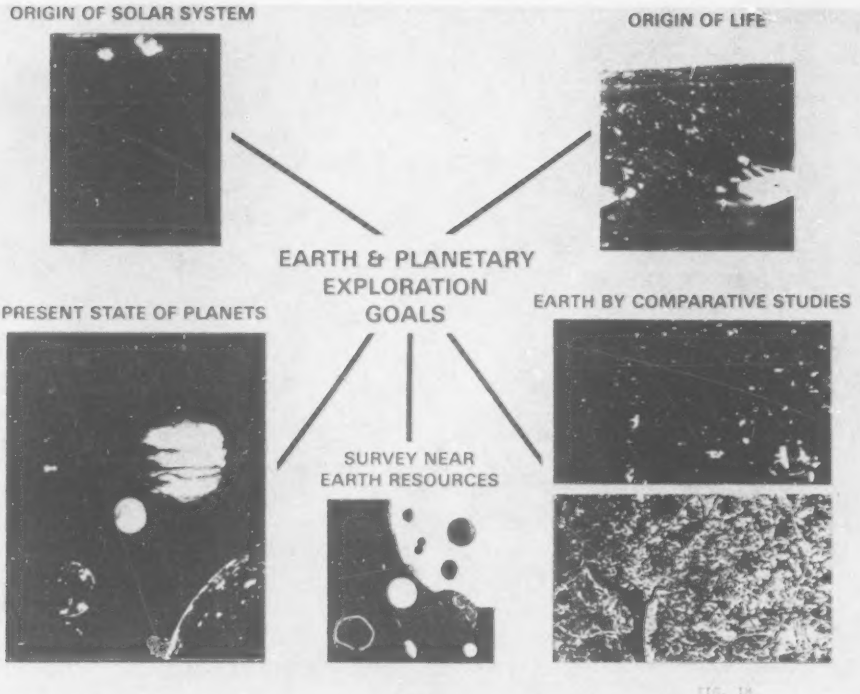

ORIGIN OF SOLAR SYSTEM
ORIGIN OF LIFE
EARTH & PLANETARY EXPLORATION GOALS
PRESENT STATE OF PLANETS
EARTH BY COMPARATIVE STUDIES
SURVEY NEAR EARTH RESOURCES

FIG. 18

LANDSAT-D

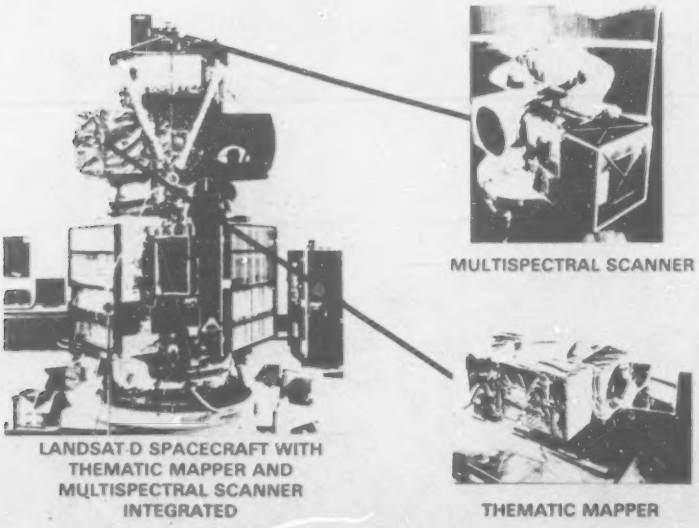
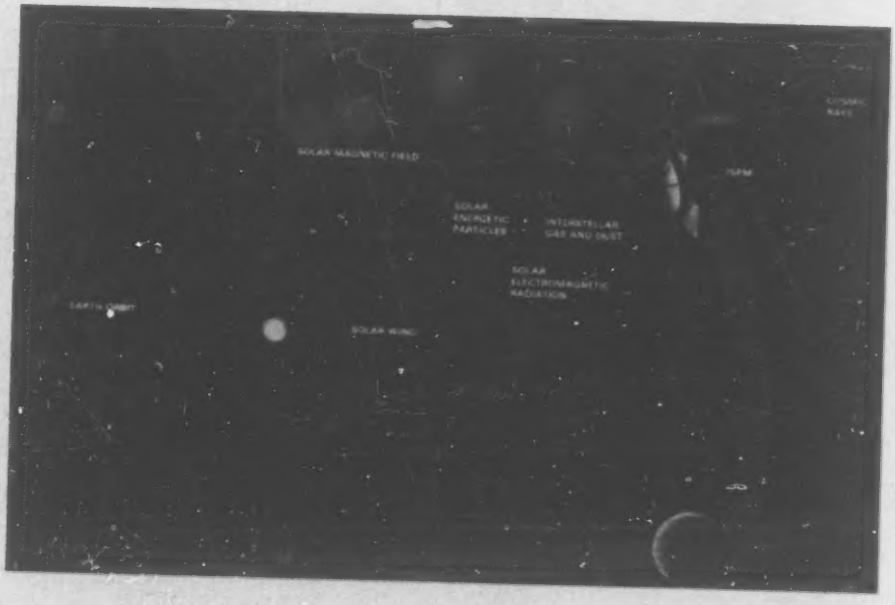

MULTISPECTRAL SCANNER
LANDSAT-D SPACECRAFT WITH THEMATIC MAPPER AND MULTISPECTRAL SCANNER INTEGRATED
THEMATIC MAPPER

FIG. 19

INTERNATIONAL SOLAR POLAR MISSION



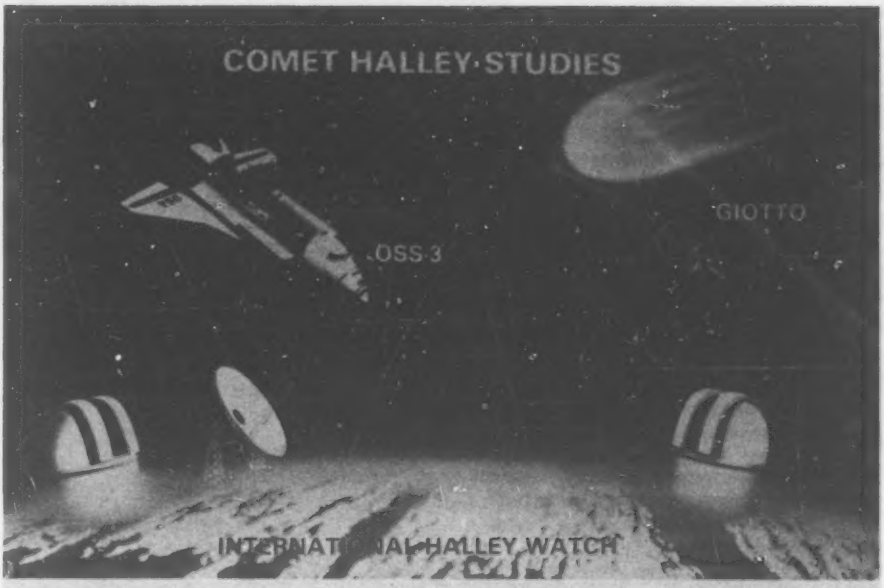


FIG. 23

ENVIRONMENTAL OBSERVATIONS

OBSERVE

ADVANCE OUR KNOWLEDGE AND UNDERSTANDING OF THE ATMOSPHERE, OCEANS AND CLIMATE

ANALYZE

FORECAST

FIG. 24

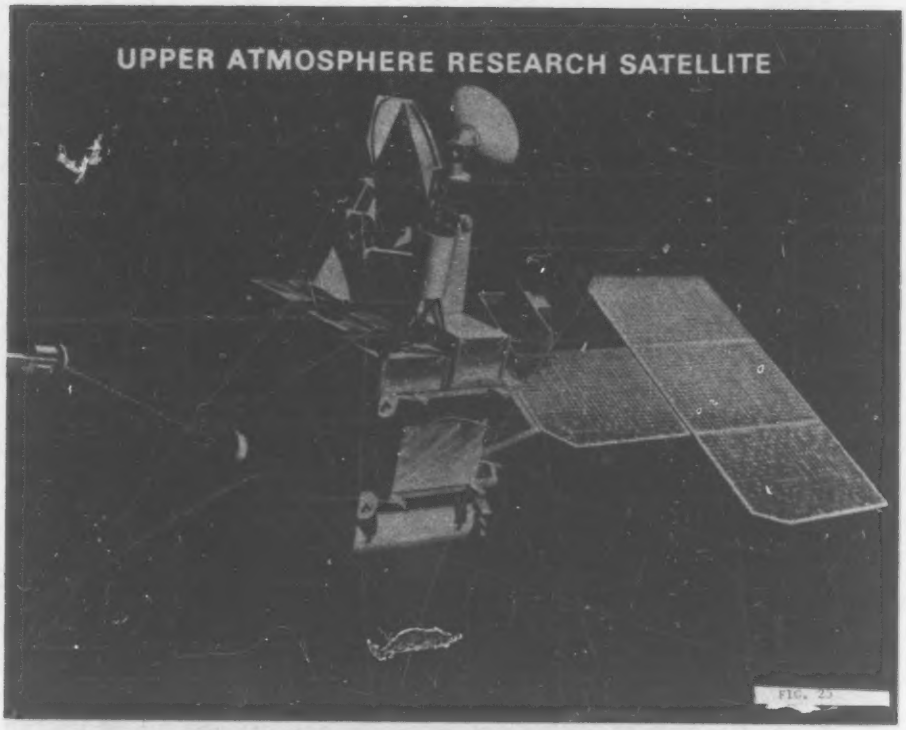
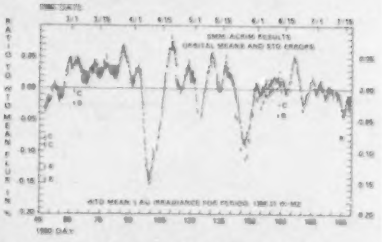


FIG. 25

EARTH RADIATION BUDGET EXPERIMENT (ERBE)



SOLAR IRRADIANCE
(DATA FROM SMM)

RADIATION BALANCE
(DATA FROM NIMBUS-7)

FIG. 26

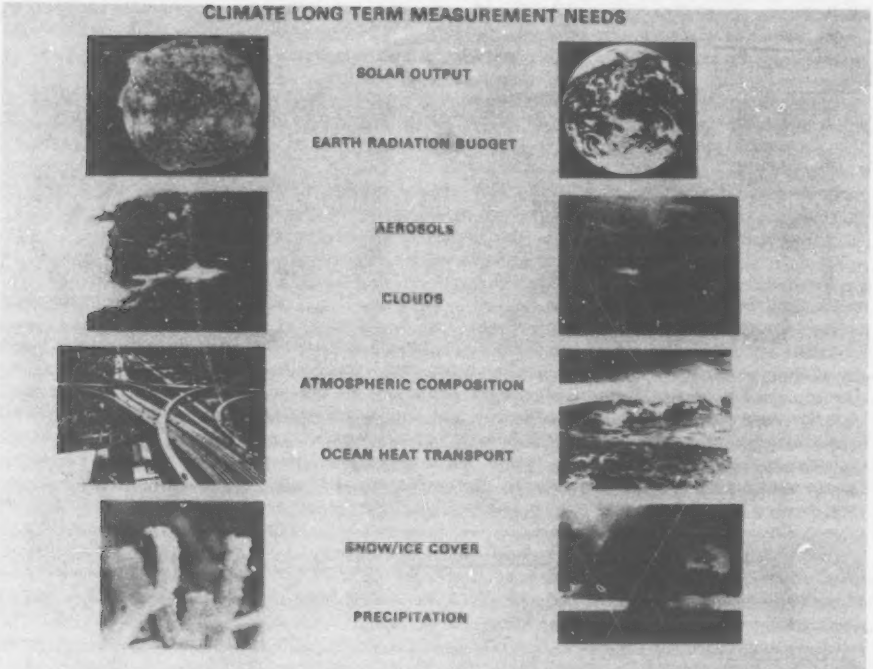
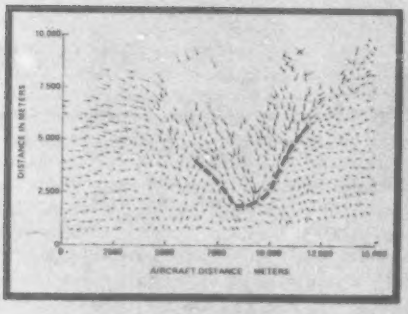


FIG. 27

WEATHER AND SEVERE STORMS LIDAR TECHNIQUE DEVELOPMENT

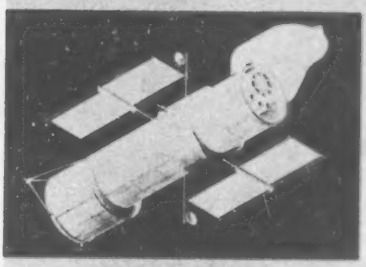


AIRCRAFT LIDAR WIND VECTOR MEASUREMENTS SHOWING GUST FRONT

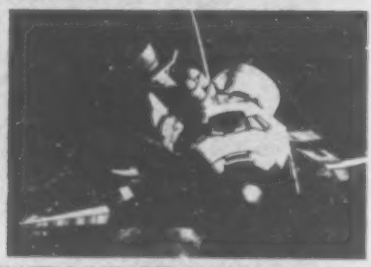
GUST FRONT EFFECTS

FIG. 28

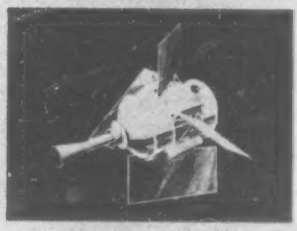
ADVANCED STUDIES
THE UNIVERSE AND THE SOLAR SYSTEM



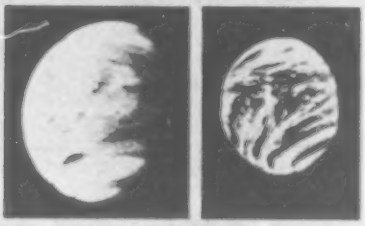
ADVANCED X-RAY
ASTROPHYSICS FACILITY



SHUTTLE INFRARED TELESCOPE FACILITY



GRAVITY PROBE B



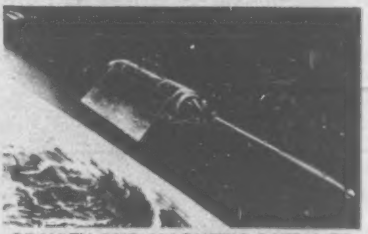
SOLAR SYSTEM

FIG. 33

ADVANCED STUDIES
THE EARTH AND THE EARTH'S ENVIRONMENT

ORIGIN OF PLASMAS IN THE
EARTH'S NEIGHBORHOOD

OCEAN EXPERIMENT
TOPOGRAPHY



GRAVITY AND MAGNETIC SATELLITE

MULTISPECTRAL LINEAR ARRAY

FIG. 34

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE HEARING ON FEBRUARY 22, 1982

QUESTION E-1:

You are looking at NASA activities that could be "more appropriately" done by the private sector. (pg. 4) Other than the 30/20 GHz demonstration, what are you looking at? When will you send us your recommendations on these?

ANSWER E-1:

We are broadly reviewing all NASA activities with the objective of encouraging the transfer of technology developed by NASA to the private sector. In addition to communications satellite technology, certain activities involving the development of value added user data packages applicable to Landsat applications are being reviewed, as well as programs in the technology utilization area which, in the past, have been jointly funded by Government and industry. As specific items are determined suitable for transfer they will be identified in the budget submissions.

QUESTION E-2:

a) With all the programs NASA has underway, it would seem that activities in the Applications area could have some of the most tangible short-term payoffs for the country thereby helping economic recovery. If this is the case, why have these activities been so drastically reduced in the FY 1983 budget?

b) If you had an extra $50 million for Applications in 1983 (and could assume some reasonable run-out support in future years) what programs would you support? List them in priority order with funding level.

ANSWER E-2:

a) Many activities in the Applications area do have tangible short-term economic benefits for the country. Each of these has been reviewed for consistency with the requirement for restraint in Federal spending. Most of these programs are being continued. The Applications budget request for FY 1983 has not been "drastically reduced" but, in fact, continues the funding for essentially all ongoing activities.

b) The FY 1983 budget request provides for a balanced Space Science and Applications program which supports the President's economic recovery program. If additional funds were appropriated for the Space Science and Applications program, they would be used to enhance ongoing efforts such as Explorer development, Research and Analysis efforts, Planetary MO&DA, the AgRISTARS program, Geodynamics, Laser Network Operations, Environmental Observation AR&DA, Shuttle Payloads effort, etc. In addition, new efforts which have been in the definition phase for some time would be initiated such as new Spacelab payload development, new Explorer development, etc.

QUESTION E-3:

a) Is NASA planning to build and fly any more remote sensing satellites after LANDSAT-D'?

b) What is the status of LANDSAT-2 and-3?

c) Are there any new problems with LANDSAT-3 that might affect currently scheduled launch of D or D'?

d) What is or would be the impact of the loss of LANDSAT-2 now? Will there be a data gap? Can any mission operations funds be saved?

ANSWER E-3:

a) The policy for remote sensing satellites after Landsat-D' is being developed by a Cabinet level council. The issues under discussion are: (1) the need for data continuity for the Federal agencies; (2) how those needs can be satisfied; and (3) the development of plans for private sector take-over of the system.

b) Landsat-2 has an inoperative control wheel which has caused loss of the spacecraft's precise pointing capability. This loss of capability precludes the acquisition of data.

Landsat-3 has suffered the loss of an optical pulse in the Multispectral Scanner which provides information necessary to produce a full image. A ground processing software correction has been implemented; however, due to the anomaly, the image width has been reduced to approximately 120 km from 185 km. This reduction in image width does still permit contiguous earth coverage north and south of 35° latitudes (due to overlap) but has reduced the coverage in the lower latitudes.

c) The problems experienced with Landsat-2 and-3 have appeared previously. Consequently, corrective actions have been factored into the design of the Landsat-D spacecraft and instruments; no delay in the launch of Landsat-D is anticipated.

d) If Landsat-3 will continue to function until Landsat-D is launched, the loss of Landsat-2 will only affect those users which require 9-day coverage (instead of the 18-day coverage from one satellite). More frequent coverage is helpful for crop classification where only a very short phenological window is available to allow discrimination between certain crops.

NASA is reducing data acquisition by foreign ground stations and non-essential U.S. users, to insure data continuity until Landsat-D is operational.

No saving in operational funds is possible because the same control center and operational manpower is required for one or two satellite operations.

QUESTION E-4:

a) The present NASA plan is to phase out support for development of an operational system and concentrate on research and development of improved sensors of finer resolution and increased data rate. Many segments of the customer community have not yet decided that the present resolution and data rate are worth the cost. Improved resolution and increased data will increase the cost of processed data per frame or per unit area. Increasing resolution from 40 meters to 20 meters increases cost four times. Under these circumstances, is it rational for NASA to concentrate on completing the present LANDSAT experiment and demonstrating and evaluating the worth versus cost of the information which can be derived from it?

b) Is it consistent that the Administration should plan to cease supporting operational LANDSAT and at the same time investing at GSFC in a Landsat Data Analysis Facility which furthermore competes with private value added service companies?

ANSWER E-4:

a) NASA's plan does emphasize the development of the enabling technologies required for an advanced solid state sensor with improved spatial and spectral resolution. However, the improved resolution does not necessarily imply increased data rates since the solid state sensor of the future will incorporate on-board data processing and compression circuits which can significantly reduce the raw data rates. Additionally, the improved geometric fidelity and inherent spectral registration characteristics of a solid state sensor will simplify the ground processing requirements and significantly reduce the cost of rectified data. Finally, based upon the trends in ground processing equipment and the applicable advances anticipated, the cost of processing the improved resolution data on a per frame basis may be actually less costly than today's cost for a Landsat image. In the meantime, as an element of our R&D role, we intend to continue to work with customers to evaluate the cost effective use of Landsat, in particular, Thematic Mapper data.

b) The Administration's position with regard to the future of the Landsat system is now under review. Regardless of a final decision to commercialize Landsat, the data analysis facility being developed at GSFC is required to process data which will be derived from Landsat-D and -D', both of which will be launched and are expected to provide data through approximately 1988. These facilities do not compete with the private value added service companies, since they are only used for the initial data processing which is required prior to the activities of the commercial organizations.

QUESTION E-5:

How will NASA support NOAA's responsibility to manage LANDSAT-D?

ANSWER E-5:

NASA will support NOAA in managing Landsat-D by providing technical assistance to NOAA in the solution of problems, implement system

enhancements and modifications requested and funded by NOAA, manage and provide technical oversight of Landsat-D' storage, and NASA will be responsible for the checkout of the operation of Landsat-D with the Tracking and Relay Satellite System. It should also be noted that NASA has total management and technical responsibility for the development of the Thematic Mapper data processing system.

QUESTION E-6:

Why did the Landsat-D launch vehicle cost increase about 200 percent in FY 1982?

ANSWER E-6:

Although the Delta project has experienced cost increases, the total Landsat-D launch vehicle cost has only increased by $2.9 million since the FY 1982 Amended budget submission. The launch vehicle cost associated with Landsat-D is based on an allocation of specific launch vehicles by the Delta project. In the case of Landsat-D, the FY 1982 increase reflects a rephasing of assigned costs based on a shift to a different Delta 3920 vehicle.

QUESTION E-7:

During its short lifetime the synthetic aperture radar (SAR) aboard the Seasat satellite was very successful over both sea and land. This instrument is obviously a very useful supplement to the optical instruments on LANDSAT, particularly over cloud-covered areas. Shuttle radars which are up only a few days are, in no sense, an adequate substitute. In view of this, why does not NASA have a program to launch free-flyer radar which would operate continuously throughout the year?

ANSWER E-7:

Many important imaging radar scientific research issues do not require either seasonal or long-term data sets from space, but do call for calibrated multiparameter images of the earth on a planetary scale. The Shuttle provides a relatively inexpensive and adequate platform for testing the influence of wavelength, incidence angle, and polarization parameters on radar imagery for geological, hydrological, and land cover remote sensing. Later generation free-flyer radars will be required to extend these tests to seasonal or long-term experiments such as vegetation identification or geobotanical studies. Imaging radar tests on the Shuttle will provide basic multiparameter data needed for the design of these future free-flyers.

QUESTION E-8:

a) The completed LACIE and the ongoing AgRISTARS programs have engendered worldwide attention, interest, and enthusiasm. In view of this, is it wise to prematurely phaseout the AgRISTARS program as NASA is now doing?

b) How much is the Department of Agriculture contributing to AgRISTARS? How much is NOAA contributing? You say (on page RD7-8)

that the information needs being met are USDA "requirements". Shouldn't USDA be paying for virtually all of the costs?

ANSWER E-8:

a) In support of the President's economic recovery program, NASA has reduced funding levels on a number of programs including AgRISTARS. In addition, the NASA role in AgRISTARS has been somewhat redefined. The NASA AgRISTARS program now emphasizes the research and development necessary to identify and validate basic techniques for extracting useful information from remotely-sensed data to inventory vegetation types and assess their condition. The large-scale testing and operational capability of these techniques has been transferred to the Department of Agriculture (USDA). Future NASA involvement will depend, in part, on the ability of the different agencies to adopt this technology. It is anticipated that NASA will be called upon to combine its unique remote sensing research and development expertise with complementary resources from USDA to solve technical problems impeding the adoption of the technology. This continued research and development role is consistent with NASA's plan to design and develop improved instruments and fundamental techniques for acquiring and evaluating remote sensing data.

b) In FY 1983, the Department of Agriculture has budgeted $12.5 million for the AgRISTARS program; NOAA has budgeted $3.1. When the AgRISTARS program was developed, each participating agency agreed to budget for its respective portion of the program. Since NASA has the capability and expertise in the development and initial testing of new remote sensing techniques, most of the early AgRISTARS program was by NASA. Our current planning assumes that the Department of Agriculture will conduct most of the large scale testing of basic techniques developed by NASA.

QUESTION E-9:

The Earth Radiation Budget Experiment (ERBE) is discussed in the first paragraph of page 5.

a) You mention a 1984 launch date. Is that the original schedule? If there has been a delay, why? What impact will NOAA launch delays have on this NASA experiment?

b) On page RD-7-5 you say that ERBE "will provide virtually all of the essential observations needed to understand this phenomenon." The phenomenon referred to is the flow of solar energy through the environment and back to space. Will we see no more requests for funds to procure data in this area? What about the 22-year sunspot cycle and its correlation with climate? This seems to indicate a coupling between solar activity and earth climate. Is it well understood or will it be when ERBE is done? How long will ERBE take data?

ANSWER E-9:

a) The 1984 launch date for ERBS was based on the STS and NOAA launch schedules existing at the time the Request for Proposal was released to industry. However, due to Shuttle development delays

and NOAA FY 1982 and FY 1983 budget constraints, the planned launch date for ERBS and for NOAA-F and -G, respectively, are under review. Launch rescheduling efforts are underway by both NASA and NOAA in order to obtain the desired satellite schedule overlap for data collection.

b) The referenced statement on page RD 7-5 of the budget book referred to only the earth radiation budget and not the total of all solar energy throughout the environment. The ERBE will measure all three components of the earth's radiation budget, namely, the incident and reflected solar energy, and the thermal energy emitted by the earth. An understanding of the physical mechanisms responsible for the radiation budget, however, must be obtained from a broad based research program involving theoretical studies and model development. This research includes an attempt to understand the relationships of solar variability with climate. ERBE will make a major contribution to our knowledge. In this connection, recent measurements by the SMM and Nimbus research satellites have provided the first real evidence of natural variations in the total solar irradiance (solar constant) of up to 0.2 percent for periods lasting up to two weeks. Climate modelers believe that variations of this magnitude could cause observable changes in climate if sustained for periods of months or longer.

It is important that these measurements be continued for at least one solar cycle to answer some of the fundamental questions regarding sun-climate coupling. Planning is currently underway to define the requirements and technology for such future observations. Funding requests will, most likely, be submitted after these plans become firm.

ERBS has a design life of two years and the NOAA satellite series has an 18-month design life. However, the NOAA series has demonstrated over two years of operations with no problems. We will continue the ERBE data acquisition as long as the satellites are healthy. The Environmental Observations Extended Mission funds will be used for these operations and we will plan for ERBE support as a part of that mission.

QUESTION E-10:

When will you begin development of a spacecraft to carry the Upper Atmospheric Research experiments?

ANSWER E-10:

NASA is actively engaged in definition of specific requirements for an Upper Atmospheric Research mission. The initiation of such a mission, including the development of the spacecraft and other systems, is expected to be a high priority OSSA candidate for a new start. Development can be expected to begin in context of both the state of mission definition and the priorities given to other activities.

QUESTION E-11:

You refer to the "decision to allow the private sector to assume" Technology Transfer efforts.

a) Do you have indications that the private sector will assume these efforts? Please give examples and document.

b) Remote sensing technology is particularly complex and expensive and there is virtually no private-sector industry. Isn't it appropriate for the good of the Nation that we encourage the development of such an industry? If you believe such an industry does exist independently of Federal funds, please document your belief.

ANSWER E-11:

a) We do have indications that the private sector perceives remote sensing, on a long time basis, as a viable market and one that will provide the necessary profitability to be perceived as a reasonable commercial venture. Over the past few years, several private sector companies have begun to provide remote sensing analytical services and products to the user community. Most of these projects involve proven techniques and applications and involve the use of Landsat Multispectral Scanner (MSS) data. Examples of companies involved in providing such remote sensing services are Earth Satellite Corporation, Washington, DC; ERDAS, Inc., Atlanta, Georgia; GeoSpectra, Inc., Ann Arbor, Michigan; and General Electric, Beltsville, Maryland.

b) We agree that there is a need to encourage the further development of the remote sensing industries. Such encouragement is being accomplished through efforts to avail private industry of our developments in remote sensing through open workshops and conferences, as well as insuring that we do not compete with industries which are attempting to develop remote sensing product lines and business areas. We have also involved private companies as the technical arm in cooperative applications projects with users to insure that new techniques are exposed to the remote sensing industry as well as to potential user organizations.

QUESTION E-12:

Some technology activity is continued in Advanced Research and Data Analysis. Please list the specific activities from technology transfer and each of their funding levels.

ANSWER E-12:

To a large extent, FY 1983 is a transitional year in NASA's Technology Transfer program in which emphasis will move from applications of Landsat Multispectral Scanner (MSS) data to the technique development and testing of new Landsat-D Thematic Mapper (TM) simulator data. As a result, we will place more emphasis on the part of the Technology Transfer program which deals with the

conduct of experimental test and evaluation of emerging new remote sensing techniques as compared to the broad based technology demonstration projects that we have conducted in the past.

The experimental test and evaluation thrust will consist of three specific activity areas. First, permanent test sites will be established in accordance with NASA's technical requirements and user needs as a long range cost effective method for testing, evaluating and establishing state-of-the-art remote sensing technology and its utility in physically and culturally diverse user environments. Projects conducted at these test sites will address priority user resource information needs and will provide an opportunity for involvement and oversight by a network of user organizations. Secondly, we will continue to conduct, on a selective basis, joint projects with Federal, state and local government agencies and private sector organizations on a one-to-one basis in their own test environments. The test environments will be selected to be representative and of interest to similar user communities. Technical workshops will be utilized to insure broad dissemination of technology which has been validated through these projects. Thirdly, we will also continue to use universities sponsored by our University Applications Program as a mechanism to develop, test, evaluate and transfer new remote sensing techniques to users.

These three activities will be funded at a level of approximately $2.5 million in FY 1983. Approximately $1.0 million will be allocated for cooperative user projects and test site activities and $1.5 million for support of universities involved in remote sensing.

QUESTION E-13:

Is there a strong program of materials processing academic research in the vicinity of the responsible center, Marshall Space Flight Center?

ANSWER E-13:

The programs in materials processing research at academic institutions in the vicinity of Marshall Space Flight Center are being strengthened. To assist these institutions we have started research programs at the University of Alabama (both the Huntsville and Tuscaloosa campuses), Alabama A&M, and Athens State College. In addition, discussions have been held with the Vanderbilt University. The major scientific expertise on the Materials Processing in Space program is provided by about 60 investigators in roughly 40 universities and other labs throughout the United States.

QUESTION E-14:

a) Who made the policy decision (last full paragraph, p.5) "not to pursue efforts leading toward large hardware demonstration"? Is this general, or does it apply broadly?

b) At least one brand new program was put in the budget as a large hardware demonstration (costing about $100 million when shuttle launch is included.) This is the Solar Maximum Mission

Repair which will demonstrate Shuttle capabilities. Please explain this discrepancy.

c) The last sentence of the paragraph describes support of ATS-1, 3, and -5 demonstrations. How much support are they receiving? Why are they supported if the "30/20" program is not? For what are these satellites used? How much of their cost is reimbursable? If ATS-1 is the only source of intra-island communication in some areas, is it really an experiment? Are health care services involved? What is the future of ATS-1 after 1983? What is the future of health-care services now being provided?

ANSWER E-14:

a) The policy decision referred to is consistent with the Administration's policy not to spend Federal funds on large demonstration missions where it can reasonably be expected that the commercial sector would be the principal beneficiary and, thus, should be expected to assume the responsibility.

b) The Solar Maximum Mission Repair is clearly different from the 30/20 GHz program in that it will demonstrate a Shuttle capability which is of particular interest to NASA because of the requirement for on orbit service of the Space Telescope and is important to other national payloads, which would use the retrieval capability to effect great potential savings. There is no perceived commercial beneficiary who could be expected to assume these costs; therefore, NASA should fund this effort.

c) NASA supports only ATS-1, -3 and -5 spacecraft operations at the $0.5 to 0.7 million level. The experiments and demonstrations are fully supported by the sponsoring organizations, which include other Federal agencies, local governments, and private and academic institutions. NASA has been requested by the Department of State to continue support of ATS-1 in the Western Pacific. ATS-3, which is out of station keeping fuel and thus requires very little operations cost, is used in everyday emergency medical support to U.S. citizens particularly at off-shore oil drilling and production platforms.

The ATS-1 and -3 satellites are used for experiments in education, health care, emergency medical and public safety communications, law enforcement, scientific experiment support and technology development communications. ATS-5 is being used solely by the Air Force for critical data input to Air Weather Service activities which support high priority Department of Defense systems.

NASA provides support for ATS-1, -3 and -5 operations (i.e., station keeping, orbital manuevers where required, telemetry monitoring etc.), and the experiment organizations support their experiment operations including ground equipment, software development, programming, etc.

ATS-1 is not the only source of inter-and intra-island communications. ATS-1 does provide additional and often higher quality communications than that available with high frequency radio which is the principal alternative. Three experiments in the Pacific Basin area, with over 30 ground stations on 20 islands, are developing and demonstrating techniques for educational extension, agriculture, public awareness and health care information

distribution and administrative support among 12 island nations and several rim countries. Many of the island areas have come to depend on the reliable and better quality communications provided by ATS-1, but it is indeed an experiment; a network experiment in thin route telephony. We continue to learn from it and it may provide data and experiehce applicable to the Carribbean area should the United States decide to apply this technology to that region. It is perhaps worth noting that Pacific Island leaders have stated that "ATS-1 is the best example of foreign aid that the United States has ever provided."

Health Care Service is one class of experiments conducted with the ATS-1 and -3 satellites. However, these experiments include health care, continuing education and extension information and training, not just health care services.

NASA is committed to ATS operational support through FY 1983. The satellite is now being relocated to a position in the Western Pacific which will conserve the remaining fuel and potentially permit retention of station keeping control beyond 1983. Follow on options for converting some current ATS-1 experiments to commercially self-sustaining activities are being studied. Options examined included use of INTELSAT, TDRSS, relocated U.S. DOMSATS, and MARISAT; however, only INTELSAT appears to be a realistic option.

QUESTION E-15:

Last year, NASA testified that it was requesting $15.4 million in FY 1982 and projected a comparable amount for FY 1983 to carry out the Applied Research and Data Analysis element of its Communications Program. Further, NASA testified that these resources were essential to carry out its program which was designed to insure the continued availability of low-cost communications to future generations of Americans and to enable the continued preeminence of U.S. industry in the face of mounting competition from European and Japanese Government sponsored programs. Now we see an FY 1982 operating plan and an FY 1983 budget that requested $10 million and $5 million respectively for this same line item.

a) Will the failure to complete the 30/20 GHz program forfeit leadership in advanced communications satellites to foreign manufacturers?

b) It has been said in earlier hearings before this committee that perhaps the United States would have to buy advanced communications satellite technology from the Japanese. However, in the February 1, U.S. NEWS AND WORLD REPORT, there was reference to the fact in "high technology" areas, Japanese firms sometimes can and do refuse to sell technology to the United States. What will we do if this turns out to be the case with regard to high-frequency satellites?

ANSWER E-15:

a) Brazil, Columbia and Mexico each proposed communication satellite systems and other countries in this hemisphere have similar plans. The 30/20 GHz segment of the programs in Japan and

Europe have been strengthened with Japan scheduled to launch a first operational 30/20 GHz satellite (CS-2) in 1983 and they are now planning to add an advanced, third generation system in 1988. Italy plans to launch an operational 30/20 GHz satellite in 1985 (ITALSAT). Unless the U.S. communications industry chooses to maintain its technology advantage, world leadership in advanced communications satellites may gravitate away from the United States and particularly toward Japan.

b) The referenced quotation from U.S. NEWS AND WORLD REPORT strictly applies only to high technology for military applications, where Japanese law prohibit sales to foreign users. Nevertheless, potentially major problems lie in the obvious difficulty of obtaining export licenses for technology which has utility in both military and commercial applications.

QUESTION E-16:

What is the response of the user community (business and public service agencies) and manufacturers to the reductions in the Communications program?

ANSWER E-16:

Based on our conversations with representatives from the small business and public service industries, they are concerned. If the carriers do not pick up and develop this capability they are afraid that competition for limited services will sharply increase the cost of these services.

QUESTION E-17:

On page SUM-8 of the budget book you say that in communications you are going to complete "generic proof-of-concept" of technology for 30/20 GHz. How is this done without a demonstration satellite? Aren't there problems with transmitting from space down through rain? How will these types of problems be resolved?

ANSWER E-17:

The resources provided for communications technology within the FY 1983 budget request will be used to complete the proof-of-concept technology program begun in FY 1980. Proof-of-concept technology as its name implies will demonstrate that concepts are feasible and will establish attainable performance standards, but subsystems produced under this program are not fully engineered and are not flight qualified. Much of the critical design data can be obtained by laboratory evaluation of the proof-of-concept subsystem. We are investigating the cost of alternative hardware and the relative efficiency of different operating procedures for the evaluating effects, such as the effect of rain on communications, that would normally be experienced in the operational invironment. In-orbit data will not be provided by the presently planned NASA program.

QUESTION E-18:

Is MILSTAR a high frequency communications demonstration?

ANSWER E-18:

MILSTAR will operate at 20/40 GHz versus 30/20 GHz for commercial systems, but power, linearity, and bandwidth requirements are very different for the two systems. There are several activities planned in the MILSTAR program. Basically, the MILSTAR program is designed to upgrade the military's strategic/tactical communications. The first phase of MILSTAR will be a demonstration program. Lincoln Laboratories will build an experiment package for the Navy which will be integrated with a LFTSATCOM spacecraft for early demonstration of the concept. Operational versions will be built by industry for the Air Force.

QUESTION E-19:

a) What benefits have come from the Technology Utilization program?

b) What would you do with an additional $4 million for Technology Utilization for FY 1983? Please list activities and funding in priority order.

ANSWER E-19:

The Technology Utilization program is no longer under the purview of the Space Science and Applications Office, however, the Technology Utilization Office has provided the following response.

a) The NASA Technology Utilization (TU) program has facilitated transfer of technology to industry resulting in a steady stream of technological innovations and advancements affecting nearly every facet of our lives -- home and automative design, fire prevention and protection for firefighters, medical diagnostic instrumentation, bridge construction, food processing equipment, microelectronic products, computerized banking, traffic controls and highway safety, energy systems, and industrial processes of almost every description. Many of the uses of aerospace technology are highlighted annually in a NASA report called Spinoff.

b) NASA believes the TU program is adequately funded, given other priority needs and the overall necessity for fiscal restraint. However, if an additional $4 million were appropriated for the TU program, the following efforts would be expanded:

1. Applications Projects - Expand application studies to determine the most effective application of NASA technologies to solve identified problems in the public sector. Project emphasis would focus on bioengineering, rehabilitation and public safety in joint sponsorship with other mission-oriented agencies (e.g., DHHS).

2. Application Teams - Retain a second application team to assist in the identification of public sector problems, match applicable aerospace technologies and participate in studies to determine feasibility and priority of defined projects.

3. Program Evaluation and Analysis - Reinstate the program for transfer research and impact studies (TRIS) to continue identification of aerospace technology uses, analysis of benefits derived, and assess effectiveness of TU program mechanisms in achieving transfer and utilization objectives.

4. Dissemination Support - Improvements in NASA/RECON and data base management support for the NASA dissemination centers; inquiry handling support for publications, including industrial mailing list maintenance; and continuation of the Spinoff annual report series.

5. Dissemination Centers - The NASA dissemination center network would be restored to the pre-FY 1981 level to permit additional outreach efforts to provide technical information and technology assistance services to a greater number of potential users in industry than current manpower and resources will allow.

QUESTION E-20:

The European Space Agency (ESA) has expressed concern that the launch delay of Spacelab-1 and -2 will increase the total cost of their commitment to provide engineering support as stated in the Spacelab Memorandum of Understanding. (Reported in the hearing before the Subcommittee, 1982, Volume IV, page 2044).

a) When do you expect to have an estimate of the increased cost to ESA?

b) When do you expect to inform ESA of your estimate?

c) In your opinion, will it be necessary to renegotiate the Memorandum of Understanding?

ANSWER E-20:

The decision to delay Spacelab-1 and -2 was implemented a year ago as a result of both the FY 1982 Budget Amendment reductions, and the one year delay in the availability of the Instrument Pointing System (IPS) from ESA. The scheduled Spacelab-1 and -2 launch dates (late 1983 and late 1984, respectively) have not changed since that time. ESA and NASA have coordinated these new launch dates and each country will have to pay their respective share. In accordance with the Memorandum of Understanding (MOU), NASA and ESA will each be responsible for discharging the full costs of their respective responsibilities. Therefore, NASA does not expect an estimate of any cost increases from ESA nor does NASA provide ESA with estimates. There is no necessity to renegotiate the terms of the MOU, since the actions that both ESA and NASA have taken are consistent with this agreement.

QUESTION E-21:

Are there sufficient funds for analysis of data from the Explorer missions?

ANSWER E-21:

There are sufficient funds for data analysis for Explorers. However, data analysis activities for Explorers which are in the extended operations or extended analysis phases (e.g., ISEE, AE and IMP) may have to be conducted at a level lower than was previously planned which will result in a reduction in the analysis efforts, and delay in attaining the scientific results.

QUESTION E-22:

You talk about funding for the Solar Maximum Mission repair in general terms on page 6. What is the total cost of the repair mission, including Shuttle launch?

ANSWER E-22:

The total cost of the repair mission is estimated to be approximately $45-55 million. Current plans are to launch the repair mission in conjunction with the launch of LDEF, therefore, no additional funding is required for the launch of the repair mission.

QUESTION E-23:

You state that you believe that the repair of the Solar Maximum Mission is extremely important. Yet your budget shows that the FY 1982 funding for the Solar Maximum basic mission has been reduced. (pg. RD4-21). If the mission is important enough to spend scarce funds repairing it, then why are you reducing funds for mission operations and data analysis? If there are funds for data analysis elsewhere, please specify their purpose, location, and amount.

ANSWER E-23:

The funding in FY 1982 for the SMM basic mission ooperations and data analysis has not been reduced. The funding for the extended mission operations has, however, been reduced somewhat consistent with the limited capability of the partially operating spacecraft.

QUESTION E-24:

a) How much money would it cost to operate NSBF in FY 1983?

b) Why does NASA need a balloon launching facility? Can't the NASA centers launch balloons?

c) Given budget constraints shouldn't NASA support scientific research with its funds, instead of operating facilities?

ANSWER E-24:

a) The cost in FY 1983 for NASA to operate the National Scientific Balloon Facility (NSBF) is estimated to be $2.0 to 2.5 million.

b) NASA does not have its own balloon launch facility and has been dependent upon the NSF sponsored National Scientific Balloon Facility (NSBF) to launch its large balloons. No other facility with this capability and appropriate equipment exists. It is true that some small scientific balloons can be launched from Wallops Island, but these are very small in size and thus have limited instrument lift capability. NASA is currently the major user of the NSBF and without the continued support of NSBF, NASA would be forced to drastically reduce the number of balloon flight opportunities. The FY 1983 Budget Request assumes approximately 40-50 balloon launches during FY 1983.

c) The National Scientific Balloon Facility, located in Palestine, Texas, is the only U.S. facility dedicated to the launching of large research balloons. Therefore, the NSBF is required to continue scientific research with large high-altitude balloons. The program has been very productive scientifically and has provided essential development activity for space flight instrumentation.

QUESTION E-25:

Which Planetary Exploration activities submitted to OMB were excluded in the President's budget? Will you discuss these omitted programs and their importance? Emphasize activities in Mission Operations and Research and Analysis.

ANSWER E-25:

The FY 1983 Planetary Mission Operations and Data Analysis budget request to OMB included funding for the continued extended mission operations of Pioneer Venus and Pioneers 6-11, for the planning of an end-to-end multi-mission operations system for future planetary missions (under the Planetary Flight Support line) and for a higher level of research and analysis furding.

The importance of the continuing Pioneer Mission operations and data analysis lies in the intrinsic science return from these missions.

The importance of the planning activity for an end-to-end multi-mission operation system lies in the potential increase in efficiency and reduction in cost which will be attained in the mission operations activity of future deep space missions. The importance of the research and analysis efforts is that this activity forms the foundation of future planetary exploration. The research effort is complex, comprising experienced scientific teams at universities and NASA centers.

QUESTION E-26:

How much has the civil service staff for the Planetary programs been cut (in full-time-equivalents, FTE) since 1982? Since 1981?

ANSWER E-26:

The reduction from the FY 1981 actual Planetary Civil Service manpower to the current FY 1982 estimate is 12 permanent civil servants. The reduction in Civil Service staff from the current FY 1982 estimate to the FY 1983 estimate is 22 permanent civil servants.

QUESTION E-27:

Have you received any communication from the planetary research community regarding the effect of proposed funding cuts? What are their concerns?

ANSWER E-27:

The planetary sciences community has informed us that they believe the FY 1983 budget request for planetary exploration places the entire program in jeopardy. The community believes that the budget cannot sustain the basic program cohsisting of analysis of data from past and ongoing missions and research aimed at defining potential future programs.

QUESTION E-28:

What is the total cost to Galileo and International Solar Polar Mission of switching from IUS to Centaur to IUS?

ANSWER E-28:

A negligible cost was incurred by the Galileo and ISPM projects in studying the options for switching launch vehicles.

QUESTION E-29:

What has been the impact of cancelling the VOIR program of funding and personnel at the Jet Propulsion Laboratory? Have the people who were working on VOIR been reassigned to other NASA projects or have they been laid off?

ANSWER E-29:

The VOIR manpower level at JPL had built up to a level of approximately 50 people in anticipation of the initiation of the VOIR development. In support of the President's economic recovery program, the decision was made not to undertake the VOIR development efforts at this time, therefore, this manpower level has been reduced to 18, who will be working with the spacecraft and radar contractors to identify a method of accomplishing most of the original science objectives with a less sophisticated mission. The personnel not involved in the study have been assigned to other NASA or defense projects.

QUESTION E-30:

Is there enough money in research and analysis to keep the planetary research community alive until new missions are developed? What scientific disciplines are hit particularly hard by the current funding distribution?

ANSWER E-30:

The impact of the research and analysis reduction below that planned is fairly evenly distributed across the program areas and every effort is being made to maintain a viable research community.

QUESTION E-31:

On page AS-6 of your budget book you say that NASA will "Exploit the knowledge gained from current and completed program efforts by thorough analysis...of the...data obtained." Yet you have reduced funding of Missions Operations and Data Analysis, and Research and Analysis in the Planetary Program.

a) Why? Can you analyze data thoroughly with this reduced funding?

b) How much would it take to return these programs to approximately their FY 1981 funding levels? What could you accomplish if we added $10 million? What if we added $20 million?

ANSWER E-31:

a) In the planetary area, data from past missions will be analyzed slower and possibly even less thoroughly analyzed than had been originally anticipated. Several investigators can no longer be supported, therefore, certain kinds of analyses will not be performed. The specific impact, however, will not be fully understood for several more months.

b) In the mission operations and data analysis area approximately $26 million could be used to restore extended Pioneer operations and restore the Planetary Flight Support activity to its originally planned level. If $10 million were added to the FY 1983 budget request, the addition would allow the Pioneer extended mission operations efforts to be continued, plus some of the research facilities would not need to be mothballed or could be operated at a more effective level. If another $10 million were added, then the major research facility operations could definitely be continued. In additic an expansion in advanced mission studies would be permitted in support of the recommendations of the Solar System Exploration Committee.

QUESTION E-32:

You say that "Planetary Mission Operations and Data Analysis funding will support those activities absolutely necessary for Voyager and Galileo." (pg 7) Which activities are absolutely necessary? Which activities are not? What impact does this have on the mission?

ANSWER E-32:

The comment you refer to applies chiefly to efforts in the flight support area of planetary mission operations and data analysis. We are continuing to support the activities which directly support Voyager operations or will be needed for the Uranus encounter. We are also supporting the development of all operations systems which will be needed for Galileo. Examples of these efforts are telemetry processing, navigation, image processing, command generation, data record generation, and simulation systems. We have not eliminated any of these areas of support, but we have decreased maintenance of equipment and cancelled replacement of equipment, thus accepting more risk. Therefore, these reductions will not prevent us from conducting the necessary activities in support of these missions, but they have increased the mission risks.

QUESTION E-33:

NASA is considering the impact of curtailing or terminating Pioneer Venus and Pioneer 6 through 11 operations and data analysis? When do you expect to complete this impact study? May we have a copy?

ANSWER E-33:

The study on the impact of terminating the Pioneers extended operations is ongoing. We are preparing an internal NASA report to assess the impact of these possible terminations and a preliminary assessment should be available this summer. We will be happy to provide a briefing on these findings at your convenience.

QUESTION E-34:

Pioneer-10 and -11 are operational and on trajectory pathways that will ultimately take them out of our solar system in opposite directions.

a) If operation of these spacecraft is terminated in January of 1983 (Budget book, page RD 5-10) do you believe that we would be using our funds most wisely?

b) How much money would be needed to continue their operation and data analysis?

ANSWER E-34:

a) Pioneers 10 and 11 are now operational and on trajectories which will take them out of the solar system in opposite directions. The FY 1983 budget request assumes operation through January 1983; however, we are continuing to determine some way to avoid turning these spacecraft off. It is not pleasant to consider the potential loss of science which will be caused by these terminations, however, we believe that the Planetary mission operations and data analysis funds are best spent on continuing Voyager operations and preparing for Galileo operations.

b) The funds which would be required to continue Pioneers 10-11 operations without sharing facilities and personnel with Pioneer Venus are estimated to be $2.5 million per year. This cost would be reduced

to approximately $2.0 million per year if Pioneer Venus were also continued in operation.

QUESTION E-35:

If spacecraft operations are terminated, can operations be presumed at some future date, without repair to the spacecraft? Address the Pioneer, Voyager and Viking spacecrafts.

ANSWER E-35:

Pioneers - Normal mission operations and data analysis are planned for all Pioneer spacecraft in FY 1982. There will be enough funding to provide minimal survival operations without data analysis, during the first quarter of FY 1983. The plan is to shut off all Pioneers by January 1983. The Pioneer 6-9 spacecraft will probably remain operable without actually being operated for approximately four months. Pioneers 10 and 11 need almost daily contact to maintain antenna pointing. The Pioneer Venus orbiter also requires daily communications to assure antenna pointing, attitude adjustment, and power conditioning. There would be little chance of reacquiring communications with Pioneers 10 and 11 or Pioneer Venus once operations had been discontinued for more than a week.

Voyager - Current funding plans provide for Voyager 1 and 2 mission operations through the encounter with Uranus in 1986. If it should become necessary to halt Voyager tracking operations, the spacecraft would perform normally for about one week. They could be placed in a special quiescent state to enhance reacquisition later, but the chances of success after a few months of inactivity would be low.

Viking - Viking mission operations have not been budgeted in FY 1983. The operating spacecraft, Viking Lander 1, currently requires uplinks at weekly "windows"; these uplinks initiate the data downlinks. If no uplink were received for eight weeks, the spacecraft would initiate automatic downlinks at weekly intervals as long as the equipment functions.

QUESTION E-36:

a) Do you have a general philosophy about the correct time to terminate mission operations or data analysis?

b) What is the rationale for terminating Mars data analysis activity in FY 1983? Will most of the analyses be completed by that time?

ANSWER E-36:

a) The appropriate timing of the termination of data analysis for any given planetary mission can only be determined by continuous monitoring of progress being made in that area. Specifically, as long as valuable scientific results are being acquired and funding permits, we will continue mission operations.

b) The Mars Data Analysis Program was started in 1979 and its purpose was to analyze specific, well-defined scientific problems on Mars. This analysis is implemented through the development of

correlated multi-instrument data sets and the development of new data processing techniques applicable to the Viking imaging data. The decision to terminate this activity in FY 1983 was made in recognition of its lower priority relative to other research and data analysis activities. Most of the analyses will not be completed by FY 1983.

QUESTION E-37:

In addition to the International Halley Watch, does NASA have any cooperative agreements to obtain Halley's comet information?

ANSWER E-37:

NASA is providing support for U.S. Co-Investigators for 9 of the 10 experiments on the ESA Giotto mission to Comet Halley. Giotto is not a cooperative NASA-ESA mission. However, for each of the 9 experiments, written agreements exist between the European Principal Investigators and the American Co-I's which state: 1) that the American Co-I's will have immediate access to the comet data, and 2) that the data will be released to the NASA National Space Science Data Center approximately one year after its receipt. In the case of two of the experiments, similar agreements exist directly between NASA and the corresponding agency in the country of the Principal Investigator. One of the NASA agreements with the Federal Department of Interior of Switzerland, was initiated by NASA because the U.S. involvement in this experiment is unique as it included some hardware development. The second NASA agreement, with the French National Center for Space Studies (CNES), resulted from a request from CNES for such an agreement. NASA is also planning to fly payloads on the Shuttle during the Halley's Comet apparition to obtain data. In addition, NASA is coordinating the International Halley's Comet Watch to coordinate world-wide comet observations.

QUESTION E-38:

NASA has announced that to save money in the data analysis portion of the space science budget, the Lunar Curatorial Facility may be shut for a period of time.

a) During this period of time, will scientists have access to the lunar material?

b) Will this action in any way damage the lunar samples?

ANSWER E-38:

a) If the Lunar Curatorial Facility has to be shut down, scientists would have no access to lunar samples, antarctic meteorites, space exposed hardware, and cosmic dust collections stored there. Complete closure of the facility is not a certainty, however, and options for limited levels of operation are being considered.

b) Closure of the Lunar Curatorial Facility would not damage the collections housed there. The integrity of the samples could be maintained.

QUESTION E-39:

What is the status of discussions between NASA and NSF over the future of the Infrared Telescope Facility (IRTF)? If NASA will no longer be one of the operating agencies at IRTF should it fund part of the mid-level facility supporting IRTF?

ANSWER E-39:

In mid-January 1982 an inquiry was made of the NSF Director, Division of Astronomical Sciences, by the NASA Earth and Planetary Exploration Division to determine the possibility of NSF picking up the operation of the Infrared Telescope Facility. Following internal NSF discussions with the NSF Assistant Director for Astronomical, Atmospheric, Earth and Ocean sciences, the reply was that it would not be possible for the NSF to pick up the IRTF as they were themselves under severe budget limitations. NASA is and has been the only operating agency of the Infrared Telscope Facility. However, there are other telescopes on Mauna Kea whose personnel require the use of the Infrared Telescope mid-level facility. Therefore, NASA support for this part of the mid-level facility will proceed even if NASA is forced to "mothball" the IRTF temporarily. A final decision as to whether the facility can be operated in FY 1983 has not yet been made by NASA.

QUESTION E-40:

a) You show $347,700,000 in the reimbursable Applications program. What is that for? What are the sources of that funding? Do the funds go to the Treasury?

b) How many NASA civil service employees are associated with this reimbursable program? Do their salaries come out of the NASA Research and Program Management account?

c) Why are the NOAA reimbursable missions (GOES and NOAA satellites) carried as part of the applications program? (page RD 7-2). Should this be pulled out if it is really just a launch service?

ANSWER E-40:

a) The $347,700,000 mentioned includes two major categories of reimbursable activity: approximately $261 million is for expendable launch vehicles (i.e., Atlas, Centaur, Delta and Scout) used for the launching of NOAA, GOES, DOD, private domestic (e.g., RCA, COMSAT) and European (e.g., INTELSAT, NATO) satellites; and approximately $87 million comprises a wide range of Space Applications tasks. For example: (1) DOC/NOAA - primarily for the procurement and technical management of the NOAA and GOES satellite system and the development of satellite ground equipment for the Disaster Alert Project in Bangladesh (2) USDA - for high-altitude photography in support of the Landsat and AgRISTARS programs; (3) DOE - for Project Airstream (the measurement of radioactivity in the upper atmosphere); and (4) numerous smaller support tasks for DOD and other Federal, non-federal and private groups.

All reimbursable funds (those provided by Federal, private domestic and foreign) go to the Treasury and are credited to NASA's appropriation.

b) Approximately 296 civil service workyears are associated with this reimbursable program in FY 1982 and FY 1983. However, since salaries and benefits for these employees are reimbursed to NASA, they are not included in the Research and Program Management budget request.

c) The TIROS and GOES programs are implemented under a division of responsibility that assigns flight system procurement, launch, and checkout to NASA, and on-orbit operation to NOAA with the understanding that NOAA's budget will contain funds for the total program. The intent is to capitalize on NASA's expertise in the development of space and remote sensing systems and NOAA's expertise in servicing a user community.

The output of these spacecraft provide a key source of data for the environmental research program both for basic research and for definition of future operational improvements and augmentations. In addition, the operational spacecraft provide flights of opportunity for development programs that could not be afforded on a stand alone basis. Two examples of this are Search and Rescue and the Earth Radiation Budget Experiment (ERBE).

QUESTION E-41:

a) What Science and Applications missions are being considered for a permanent space platform?

b) Which of these activities can be conducted best from a platform versus a free-flyer?

c) What activities are being considered for a manned space station?

d) Which of these activities can be done best from a manned station versus an unmanned free-flyer?

ANSWER E-41:

a) The Space Platform concept evolved from the desire to provide an extended mission duration capability for instruments being developed for Spacelab. Although the development of these instruments is well justified for a seven day Spacelab mission, it is recognized that a mission extension from one week to several months will greatly enhance the scientific productivity of the hardware. Typical instruments considered for this category are: The OSS-3 cluster of ultraviolet telescopes, the Solar Optical Telescope, improved versions of the Synthetic Aperture Radar, and the pilot plant demonstration flight for the McDonnell Douglas/NASA joint endeavor on electrophoresis operations in space.

b) The Space Platform concept would be a free-flyer capable of supporting investigations from many disciplines but not necessarily simultaneously. Any activity which can be conducted on a space platform can also be conducted on one or more suitably designed

free-flyers. The rationale for conducting the activities on a space platform is to take advantage of economic benefits achieved by: developing one large spacecraft instead of many smaller ones; requiring only one docking for manned servicing instead of multiple dockings on more frequent flights; and providing one central communications link to TDRSS instead of multiple demands for tracking, acquisition, and data transfer.

c) Our Skylab experience tells us that man can play a significant role in the conduct of research in solar astronomy and materials processing. Man is a natural part of the investigations in Life Sciences, and as Skylab demonstrated, man is key to in-orbit assembly, maintenance and repair. We believe that man can be an asset in many other research activities and we are initiating a number of study activities to probe this question.

d) Skylab demonstrated the value of man's presence for a limited set of research goals. We intend to probe man's utility further through study efforts and through experience on Spacelab missions on-board the Space Shuttle. Typical activities which can only be done by man's presence in space include assembly, maintenance and repair of space vehicles, research on the effects of weightlessness on man's ability to perform, and some interactive experiments in materials processing.

QUESTION E-42:

The Hearth study recommended that a series of regulations be adopted for the conduct of NASA activities. Which, if any, of these regulations have been adopted? What impact have they had on the Office of Space Science and Applications? Please be specific and provide examples using the Gamma Ray Observatory activities.

ANSWER E-42:

As a result of the Hearth study recommendations, NASA implemented a set of guidelines which reiterate the basic principles of NASA project management, and which set forth specific management activities in the life of a NASA project. These management functions are intended to assure that the project is well defined; costs and risks are understood; and management roles within the Agency for a given project are unambiguous and reflect documented understanding between the appropriate program office and Center director. Key provisions of NASA project management guidelines involve the early life of the project. For example, a non-advocate "definition review" will be carried out before a project is initiated to assess the actual stage of project definition, particularly in terms of completeness of technical specifications, and the range of technical, cost, and schedule risks involved. The outcome of this review is an essential element in determining the commitment the Agency will make on the program. Another key provision of the guidelines calls for the project manager to develop control of detailed technical content and associated costs in the early development stages before contractual effort reaches full momentum.

We are incorporating some of the Hearth study recommendations in the GRO mission even though GRO was initiated prior to the Hearth study. For example, the first two years of low-level development funding have been used primarily to have the spacecraft and instrument contractors carry out initial detailed design definition and costing activities. This effort has yielded a number of design/cost tradeoffs and is contributing significantly to a clearer understanding of the project and the remaining risks involved. These initial design and costing activities will culminate in a thorough review at the Program Office level to assure that this project is thoroughly defined and schedule, cost, and risks are well understood before the Agency proceeds with full-scale engineering and flight hardware fabrication efforts in FY 1983.

Mr. FLIPPO. Thank you very much for your statement, Dr. Stofan.

In 1981, for planetary mission operations and data analysis, I think those two areas had about $112.5 million. In 1983, those two areas seem to be funded at about $62 million.

Could you tell us the impact of those cuts?

Mr. STOFAN. For the planetary program, yes. In the mission operations and data analysis, the money that we have in that line item will continue the Voyager operation and support the development of the mission operations system for the Galileo and ISPM systems.

The other support that we are carrying at the present time is under investigation. Exactly how we are going to proceed regarding Pioneer operations, including the Pioneer orbiter at Venus and the 6 through 11 Pioneer missions, is still being reviewed. We must also provide money to look at the future to determine how we consolidate control center activities at JPL. Therefore, this area is still being looked at, but we may have to terminate all Pioneer operations in January 1983.

The only thing that presently remains is the Voyager and Galileo and ISPM activities. However, we are taking a very close look to see if there is some way we can produce a more efficient and/or reduced level of effort to continue to operate the spacecraft. At the present time, it appears that the money is not there, but we have not given up; we are still trying very hard to see if we can find a way to keep them operating.

In the research and analysis area of the budget, we have had to curtail many activities, largely research grants to colleges and universities. We are also looking at a reduced operation of the lunar curatorial facility at the Johnson Space Center. We will have to reduce these activities. We are facing the possibility of curtailing the operations of the infrared telescope facility [IRTF] in Hawaii. We are conversing with the National Science Foundation and with the University of Hawaii, regarding a way that we can perhaps keep this going. However, we may have to mothball these operations temporarily.

Mr. FLIPPO. You mentioned the infrared telescope in Hawaii?

The telescope has proven to be among our most valuable assets in helping us maintain our preeminence in the field. I think there is an infrared astronomical satellite scheduled to be launched later this year with followup monitoring that was to be provided by the infrared telescope.

In this time of fiscal restraint when space exploration has been cut back so drastically, don't you consider the telescope to be a vital, cost-effective means of keeping data from space coming in?

Mr. STOFAN. It is used very extensively in the planetary exploration program, and it provides valuable bits of information to better our understanding of the evolution of our own solar system. However, in times of constrained budgets, it may be necessary to terminate some of these activities with the idea of requesting funds in the future to continue on the operation of this facility.

Mr. FLIPPO. Doctor, the communications program is being cut, and I believe that the 30/20 gigahertz demonstration is being dropped.

Could you tell us how much money might be necessary to secure long leadtime items, sir?

We all hope that the economy of the Nation will revive itself, and we can again move forward with a very strong program and we want to be in a position to take advantage of a very strong economy when that develops and I wonder how much money we would need to put in the budget now to enable us to maintain the capability to do the 20/30 gigahertz demonstration?

Mr. STOFAN. I would estimate that it will require an additional $10 million in fiscal year 1983 to maintain the capability.

Mr. FLIPPO. There has been a reorganization of reporting responsibilities in the materials processing in Space Division and the Spacelab Flight Division. What will this reorganization achieve for us?

Mr. STOFAN. I think the reorganization did achieve some internal efficiencies in operation. We will be functioning with approximately 20 less people than we did before, without degrading either the applications or science program. It is our intent, and Burt might want to say something here, to maintain a viable science and applications program and keep the balance between them.

In environmental observations and in the Earth and planetary exploration program, the synergism of combination will enhance both of those programs.

Mr. FLIPPO. What NASA center has the primary responsibility for the materials processing program?

Mr. STOFAN. Marshall Space Flight Center, with the secondary responsibility to the Jet Propulsion Laboratory.

Mr. FLIPPO. Help us with the rationale for projects that are placed with the Shuttle/Spacelab Payload Division. Are there projects that NASA plans to place with this Division in the future?

Mr. STOFAN. Yes, rather than have each one of the individual scientific discipline divisions develop their own instruments, we put that development into one area. In years prior to the reorganization, we developed some instruments for applications and some for science. This Division's primary function is to develop the instruments and integrate them into a flight. The science responsibility resides in the original division, but the development of the hardware itself is in this Division where we have a majority of engineers and project managers.

Mr. FLIPPO. Thank you.

Mr. Brown?

Mr. BROWN. I wonder if I could ask Dr. Edelson to make some comments, not so much about the NASA testimony, but you have had extensive and varied experience in the space program and its application to the civilian needs of our economy in your role at COMSAT.

You have had a chance to see the program from the standpoint of NASA. I wonder if you could offer any suggestions as to what NASA might be able to do to facilitate or encourage more substantial commercial utilization of the technology developed in this space program. I don't want to be too vague about this, but specifically some of the things that COMSAT had in mind or are actually doing, such as direct satellite, direct broadcasting of television to homes, and so on, and the development of improved data communi-

cation by satellite in various ways. Are we dealing with matured technologies here which need no further development? To take that a step further, what is the situation with regard to the availability of orbital slots. Are we prepared to take or make the necessary transitions for increasing the utility of existing orbital slots with the technologies that we have at present?

Basically I am trying to see if I can get some better understanding of where we need additional scientific and technological development in order to enhance the commercial posture of this country, and I thought perhaps you might comment on that from your role in COMSAT.

Mr. EDELSON. I will be very happy to try to comment on that, Mr. Brown.

The field of satellite communications has indeed been a successful one in every way that you can measure, particularly in terms of the operational capability it has brought to provide worldwide distribution of telephone, television, and so on. The fact is that it has developed a great deal of new and useful technology, and not least, economically it has been very effective in creating a new business which now measures something like $2 billion a year of commercial money and an overall installed plant in the world of close to $5 billion. Today, tens of thousands of people are employed around the world, and a very favorable balance of trade to the United States exists through the sale of launch vehicles and through the construction of the satellites. It is something that has been extremely successful in the world, and extremely successful for this country.

The next thing is that all of this is due to the wisdom and efforts of those in NASA who, during the 1960's and 1970's, developed the technology. The fact that this new business exists at all and is as successful as it is, has to do with the fact that NASA pioneered in the early day with the Echo, Relay, Telstar, Syncom and the advanced technology satellite programs (ATS–1 through 6) which are all predecessors to modern telecommunications satellites. COMSAT as well as other commercial entities, also certainly contributed a lot to the technology.

I know there is a question as to what role the Government, and particularly NASA, should have and I think your question was aimed at what role commercial entities would play. Although we did some grand and glorious things with the development of technology at COMSAT, the work that we did was largely extrapolation of existing technology. We developed better devices. We worked on better structures and materials and systems which were adaptations, improvements and enhancements of the basic large, giant technological advances that were brought about by the Government, and developed by NASA.

I think that there are now some needs and even more opportunities for major improvements in satellite communications which will require major expensive, large-scale development and tests.

Mr. BROWN. Give us some examples.

Dr. EDELSON. That would be very easy to do. The opening up of a new frequency band like the 30/20 gigahertz band itself is something that commercial organizations can't or wouldn't do because of the required large expenditures and the very high risk, but more than anything else, because of the length of time between invest-

ment and payoff. I have frequently been asked to comment on the contention that, if something has the potential to become a valuable commercial product, then it would be expected that industry would take it on. Indeed, industry will do it if the payoff occurs in something like 3 or 4 years at most. Commercial industry is willing to do research and development which has a good payoff in the next few years. Something with a commercial payoff of 10 years in the future, a large-scale effort, not fundamental research, won't be done by private industry.

I am saying I think NASA does have a very important role to play if the future of the satellite communications technology is to be exploited by the United States, and led by the U.S. industry, as it has been in the past.

Mr. BROWN. You see the market potential is continuing to expand in this area, that is, the market for the services that would be generated to the improved systems. For example, if we needed to move into the 30/20 gigahertz system and use groups of antenna on one platform in space, this would give us tremendous additional communication power. Is there a market for this communication power?

Dr. EDELSON. Yes, indeed, Mr. Brown.

We are just beginning to tap the potential market for satellite communications in terms of point to point trunking, which is the major use to date. We have not really started to use the other topologies of communications such as networking, broadcasting, and data collection systems. As part of your question, about the shortage of the orbital slots, and you might have added frequency spectrum. Those are problems that have to be overcome in the future. All of these are technologies which should be developed over the next few years. As Mr. Stofan pointed out, we are not going ahead with a so-called 30/20 gigahertz program that we had planned, but will go ahead with the development of the 30/20 gigahertz technology. We would like to look forward to a flight program in future years which could perhaps develop this technology more in keeping with the budget at the time.

Mr. BROWN. Well, in your statement, I sense that you have a very well defined sense of the importance and the need for development in this area.

What I am trying to discern is from the standpoint of this administration, what is the legitimate role for NASA in doing this and how it relates to the budget that is being presented here.

I presume private industry is not going to make the expenditures necessary for 30/20 gigahertz or to develop large-scale antenna farms in space and some other things like that, as far as we can see at the present.

Dr. EDELSON. I believe it is beyond the capability of the private industry to spend the amounts of money that it would take, in view of the risk and the very long-term payoff that is involved.

Mr. BROWN. If COMSAT continues its remarkable success with the SBS satellite system and the direct broadcasting program that it envisions, what does this mean in terms of its need for this new technology, the new techologies represented by the 20/30 gigahertz system and additional satellite capacity in space?

Dr. EDELSON. Well, I think I would rather not answer in terms of COMSAT, because I left them behind and am now in a new position. I would rather speak about commercial interests in general. They do look at NASA as a source of major new steps that must be taken in order to provide the capability for new commercial enterprises in satellite communications.

Mr. BROWN. Do you have in NASA—and either of you gentlemen can answer this—a capability, an institutional capability, to plan in cooperation with the private sector for some reasonable development process that would insure the continued primacy of American commercial activities in space tied in with the technolgical developments in research being done at NASA?

Essentially, what I am trying to get at is whether there is consideration given in NASA in developing your applications program to the needs of private industry for the exploitation of global markets.

Dr. EDELSON. Well, my thoughts are that cooperation with American industry is going to be essential for NASA to move ahead for two reasons. In order to be truly meaningful and useful, it has to be done with the advice and cooperation of the industrial users, and in fact the NASA program has been very well coordinated with user industry. Second, there are some very good opportunities for cooperative programs where industry participates with funds and with equipment on joint endeavors with the communications community.

Mr. BROWN. I won't belabor that.

Mr. FLIPPO. Mr. Hollenbeck.

Mr. HOLLENBECK. At the outset, I would like to receive unanimous consent to insert opening remarks at the appropriate place.

Mr. FLIPPO. Without objection.

Mr. HOLLENBACK. In those remarks I state my concern that we may be placing too much budgetary emphasis on hardware and not enough into the applications area.

In the area of communications, when we compare the original budget line items in fiscal 1982 and fiscal 1983 with the now planned operating budget for fiscal 1982 and the proposed 1983 figures, one can see that the communications segment has been steadily reduced and I wonder if you can comment on the reasoning behind that.

Mr. STOFAN. I think the main reduction in that budget line item was the decision not to go forward with a full scale 30/20 development program in fiscal year 1983. Approximately $30 million would have been needed to go ahead with the full scale development of an operational demonstration satellite.

In the communications line item the advanced research and data analysis was reduced as we looked at what we really wanted to do. Information Systems is the element that we broke out from the Communications division and it now answers directly to the front office to determine what we want to do with the advanced computer technology to enable us to handle the large amount of data from our science and technology program.

Mr. HOLLENBECK. With all the programs that NASA has underway now, it would seem to me that some activities in the area of missions could have some very tangible short-term payoffs for the country, especially in the area of communications. Do you agree

with me that this may be the case, and if so, why has that element of the budget been so drastically reduced in fiscal year 1983 in particular?

Mr. STOFAN. In looking at the overall budget structure, we came to the conclusion that, at this time, given the economic considerations, we could not come forward with the new demonstration satellite in the 30/20 gigahertz. We are looking at alternative ways in which we can possibly demonstrate this technology.

However, we still are carrying on some of the necessary research, such that if it were determined that the demonstration flight was the best way to go forward, and it could be justified on a technological basis, that option would still remain for us in fiscal year 1984.

Mr. HOLLENBECK. Now, switching over to technology transfer, this committee last year authorized some $9 million to continue those activities, and in your statement on page five you remark in the second paragraph that you are using those funds to phase out technology transfer activities. I wonder how you can square this with the stated intent of the Congress to continue transfer activities.

Mr. STOFAN. There are two aspects. One was the level of those activities in the fiscal year 1983 budget that would be contained in the basic AR and DA program in which we would carry those areas that are high technology and that require NASA expertise. In the areas where we feel we have been successful in technology transfer, we would back off. The second aspect is the budget level, which was determined looking across the entire NASA budget. Indeed, there were specific moneys added in numerous places in the budget. Also there was a 4½-percent reduction taken across the board within NASA. However, we were able to retain the $5 million in the technology transfer program in fiscal year 1982.

Mr. HOLLENBECK. In that same paragraph, though, this concerns me, you talk of transfering activities to the private sector, and later on in the budget, in the budget book on pages RD 7–5, 52 and 53, you refer to that, "Decision to allow the private sector to assume," these technology transfer efforts.

What indications do you have that the private sector will assume those activities, and if so, if you can give me some examples of that, and are we allowing the private sector to assume these efforts, are we saying that NASA has not been allowing the private sector to do that in the past?

Mr. STOFAN. I would like to ask Sam Keller to address that issue.

Mr. KELLER. At the moment, I am not sure that I can give you the kind of concrete examples you want. In trying to respond to some of the points you raised in your question, we are certainly going to do more to encourage the private sector to take over these activities, at least more than we have done in the past.

Your observation was, have we restricted the private sector from moving out in these areas. I don't think we have, but we have done nothing positive to encourage them in the past, either.

Mr. HOLLENBECK. That was more of a remark than a question. I don't think you have either.

Mr. KELLER. We will continue many of the ongoing university activities, remembering that technology transfer is a term that basically refers to the application of Landsat-type data as opposed to

the technology utilization program which applies more specifically to other areas. We do intend to keep ongoing, for the foreseeable future, the three regional centers: The one at NSTL, Goddard, and Ames. These have been our principal contact with the user community outside of the academic area. So although these items do not appear as specific line items, they are assumed within the basic Landsat budget. At the time of the reorganization, when technology transfer was to be placed somewhere else, we combined that activity with the Landsat people to whom it directly applies. I would be less than candid if I suggested that the program will continue at the same funding levels as it has in the past. Basically, what we have tried to do, within the constraints of the present economic situation, is make tradeoffs and recognize that we may not be able to proceed at a level that we might like, but at a level which we think will preserve the major aspects of that activity.

Mr. FLIPPO. Thank you.

Mr. HOLLENBECK. I have a couple more questions if you will indulge me.

Getting into planetary exploration, Mr. Beggs indicated 2 weeks ago that there would be diminishing scientific return if we launch Galileo on a Shuttle Inertial Upper Stage rather than on a Centaur vehicle, and I wonder if you could comment briefly on that.

Mr. STOFAN. Yes, when you launch the Galileo on the inertial upper stage, you have to use a Delta Vega trajectory. That adds approximately 30 months' trip time to the mission, so the satellite will arrive at the planet Jupiter in late 1989 or early 1990, and acquire data over 1990 and 1991. It will be a 30-month delay in return of science. Also, because of the limited performance capability provided by the IUS, we have to burn more of the propellant out of the orbiter's tanks in performing this maneuver. Thus, when we get to Jupiter, we have less propellant onboard the orbiter for the satellite encounters, and only 6 are guaranteed instead of 11.

If all the variables were stacked up in the right direction, we could get more than the six encounters, but we can guarantee only six encounters, therefore, our trip time will be longer and some of the encounters may be lost.

Mr. HOLLENBECK. Can we say the IUS does not have the type of growth potential for planetary missions that the Centaur vehicle can provide?

Mr. STOFAN. That is a fair assessment, yes, sir.

Mr. HOLLENBECK. Thank you.

Mr. FLIPPO. Mr. Nelson.

Mr. NELSON. Let me pick up right there, if I may.

I wanted to say first to Dr. Edelson, I would imagine that you and Mr. Stofan have the most exciting and stimulating job in the whole of NASA, now that we have pretty well got the Shuttle underway. Pretty soon it is going to be old hat, launching the STS from the cape, and now you all really have an exciting job. I want to comment on your two bosses, Mr. Beggs and Dr. Mark; they must be pretty good people to work for, and our committee's relationship with them has been very good and we are impressed.

Now, what I would like to do is pick up on Mr. Hollenbeck's questions and take it from there.

You spoke of the difference that you could only guarantee 6 Jovian orbits as opposed to 11 if launched by Centaur.

You also stated that IUS is going to be launched in 1985 and arrives when, in 1987?

Mr. STOFAN. No, in 1990.

Mr. NELSON. If it was launched by Centaur, it would go when?

Mr. STOFAN. We would get there in 1987 with a Centaur, or late 1989 with an IUS.

Mr. NELSON. 1987 versus 1989?

Mr. STOFAN. Yes.

Mr. NELSON. Have you ever flown an IUS?

Mr. STOFAN. Not to date. However, the IUS is the upper stage for the tracking and data relay satellite.

Mr. NELSON. Centaur has, it has flown a lot of times, three missions?

Mr. STOFAN. The existing Centaur has flown 60 missions. The modifications would have to be made before it could fly on the Shuttle.

Mr. NELSON. What has been the success rate of Centaur?

Mr. STOFAN. Greater than 90 percent.

Mr. NELSON. Better than 90 percent.

All right, you mentioned that you were talking about a Delta Vega trajectory, and I am not sure I understand all of that, except that you said by the time that you got to your destination, that you would only have enough fuel for 6 Jovian orbits versus 11.

Mr. STOFAN. Correct.

Mr. NELSON. How many pounds can you lift with IUS.

Mr. STOFAN. That depends on where you are trying to put it.

Mr. NELSON. For the Galileo-Jupiter mission?

Mr. STOFAN. I don't recall that number.

If you try to fly a direct trajectory, which takes 2 years from the Earth to Jupiter, the wide-bodied Centaur can do that with a margin of a few hundred kilograms. The IUS is several hundred kilograms short in performance of going on a direct trajectory. Therefore, we must fly out from the Earth and come back around the Earth to pick up energy from it that is lacking in the IUS stage to get us to Jupiter. With the performance the Centaur could provide, we could fly on a direct trajectory.

Mr. NELSON. I can assume from your answer that Centaur has a greater lift capability than IUS?

Mr. STOFAN. Appreciably greater. For direct comparison, if you talk about putting weight in geosynchronous equatorial orbit, you are talking 4,000 to 5,000 pounds for the IUS. You are talking about a 2 to 1 ratio.

Mr. NELSON. Tell me why in the world has NASA decided to go with IUS instead of Centaur?

Mr. STOFAN. [No response.]

[The information follows:]

The lift capability of the IUS, from the Shuttle to geosynchronous orIbit, is 5,000 pounds. The long wide-body Centaur would be capable of placing about 13,000 pounds into geosynchronous orbit.

The basic IUS is a two-stage, solid-propellant vehicle which is being developed by the Air Force and planned for DOD, NASA, and civil use. The first flight of the two-stage IUS is scheduled for late 1982. The IUS has redundant critical components such as navigation and guidance avionics, reaction control systems and backup elec-

trical power supplies which will provide a calculated vehicle reliability of better than 98 percent. It uses two solid-propellant motors, a large first-stage motor containing 21,400 pounds of propellant and a smaller second-stage motor with 6,000 pounds. A second-stage motor extendable exit cone to provide increased performance is standard with the STS configuration.

The Centaur upper stage is a wide-body derivative of the highly reliable Centaur expendable stage. The Centaur is a liquid-hydrogen-fueled stage utilizing two RL-10 engines with multi-burn capability. The development efforts would take advantage of the current Atlas Centaur design to accomplish required performance parameters and compatibility with other existing elements of the STS. The Centaur in Shuttle is a moderate risk development requiring between three-four years.

Mr. NELSON. You said you could get there by 1987 instead of 1989, and you said IUS has never been tested, and that Centaur in 60 missions has been over 90 percent effective, and you have said lift capability is much greater.

Now, why would we go then with IUS instead of Centaur?

Mr. STOFAN. There are two considerations. One is the risk of not being able to develop the new Centaur in time to support the 1985 Galileo launch. I don't think the risk is very high, but it had to be considered.

The other consideration was a near-term budgetary problem. If you look at the runout of the two programs supporting Galileo and ISPM, the two launch mode costs are very close. However, if you look at the short term funding requirements, the Centaur budget requirements were much greater than the IUS, and that influenced the decision.

Mr. NELSON. May I indulge the subcommittee to take one more moment.

Mr. FLIPPO. Surely.

Mr. NELSON. He made my budgetary ears perk up.

You said in the long run the two as compared to each other are very close in cost?

Mr. STOFAN. Yes.

Mr. NELSON. In the short term you need less funding with IUS?

Mr. STOFAN. Correct.

Mr. NELSON. Let me see if I can understand this. The long term, the cost to the U.S. Government is going to be about the same, and in the performance of the mission over the long term, you have just reiterated to Mr. Hollenbeck and me a number of things that would indicate that Centaur is far superior to IUS.

Therefore, by your comment and the only reason that NASA has selected it is that in the short term IUS is less expensive than Centaur. Am I to conclude that is the case?

Mr. STOFAN. Yes, along with consideration of the risks in meeting individual launch dates.

Mr. NELSON. Explain that, please.

Mr. STOFAN. The risk is lower in the IUS stage because it has undergone testing and the development is well along. The changes to the Centaur have not been developed, and that requires a different method of operation and Shuttle changes.

Mr. NELSON. Instead of making it slender, making it squat?

Mr. STOFAN. No, we are talking about the wide body Centaur. It is making the Centaur big enough around so that it fills up the Shuttle bay. We do have a lot of sunk costs in the IUS development with the Air Force where we do not with the Centaur. I might

point out that you are dragging me a bit astray; I am a space science and applications man, and these questions would more appropriately be answered by the people in the Space Transportation Systems Office.

Mr. NELSON. You want to report these questions to them?

Mr. STOFAN. I will be more than happy to.

Mr. NELSON. Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Brown, did you have a followup question?

Mr. BROWN. If you have some additional time.

Mr. FLIPPO. I certainly do.

Mr. BROWN. Mr. Stofan, I think we all understand the budgetary situation that faces us, and the necessity for NASA to share in some of the suffering that is taking place. I don't think any member of this subcommittee wishes to embarrass any of you in any way, but we do need to understand the implications of these reductions in some of these programs, and whether from our standpoint the budget is serving the national need and the national welfare as well as it might.

The real thrust of my questions with regard to the communications and information systems, for example, was whether or not the cutbacks that are indicated in your budget figures may not actually be inhibiting the administration's own desires to stimulate additional economic activity, and the development of a better posture for this country in global technology marketing. From that standpoint, let me ask you what the 3- or 5-year figures are, if you have them, for that item which you have listed here as communications and information systems which show proportionately the largest reduction of any of the items, I think, in your budget, a drop from the March amendment figures of $30.3 million down to a request of $19.9? If you factor in a little bit of inflation, you are down to about half of your actual program, in a 2-year period.

What is the future looking like in this area?

Mr. STOFAN. I think most of that money is in basic A.R. & D.A. and search and rescue, with a small amount of money in the basic 30/20 gigahertz activities. As I mentioned, the agency did not bring forward a 1983 new start for a 30/20 GHz demonstration project. We are preserving the option to bring forth some type of technology demonstration or high technology program that would prove out some of the concepts of the program we are involved in. We are doing the necessary work to allow us to come back and address this issue in fiscal year 1984. We will take a very, very hard look at it within the development of the fiscal year 1984 budget which starts this spring.

Mr. BROWN. You will take a hard look at submitting that as an additional start for funding for 1984, you mean?

Mr. STOFAN. Yes, that option has been preserved with the A.R. & D.A. money, so if we determine that that can be worked out with the administration, and that is what we want to do, we could do it in fiscal year 1984. We will be revisiting that whole area.

Mr. BROWN. That is not exactly what I asked and you may not be able to answer it but most of the budget books that I have looked at show a 5-year anticipated budget for these items.

You don't have any figures for the next 3 years as to what you are shooting at in your overall budget here?

Mr. STOFAN. It depends on what program we come forward with. Within the fiscal year 1983 program we submitted, it is well understood what we are doing. The development of the fiscal year 1984 budget will be finalized this fall and the runout of the effects of that program on fiscal years 1985, 1986, and 1987 will be estimated.

We will readdress this area, bring forward the proposed options we want and show the runout of the new program.

Mr. BROWN. What you are showing is a decreasing budget?

Mr. STOFAN. It always shows a decrease as major programs slack off. Each year we come back to propose new starts and enhancements to the ongoing programs. That is the way we have to present the budget.

Mr. BROWN. All right. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you, Mr. Brown.

Mr. Keller, I believe you said that the technology transfer program is being continued in advance research and data analysis. For the record, exactly what is being continued in that area, and at what budget level?

Mr. KELLER. Mr. Chairman, in order to give you very precise figures, I would like to submit those for the record. Basically we will continue the majority of the university program. We will continue the regional centers and there are other specific activities which we can address and show you where the various items are in the budget.

Mr. FLIPPO. Could you perhaps also include what is being lost?

It is the announced intention of the administration to phase out the funding for development of an operational data processing system for the—beyond the Landsat-D′—isn't that correct?

Mr. KELLER. Mr. Chairman, Let me put it this way: As of right now, the administration has no commitment to data continuity beyond the Landsat-D′ spacecraft. We will launch Landsat-D′ hopefully in July of this year, and assuming we get a 3-year lifetime, which is reasonable to expect based on our past experience, we would launch Landat-D′ 3 years later or whenever it is necessary.

There is, at the present time no commitment to continue data continuity beyond that time, unless, of course, the private sector should pick up the program. My understanding is that major aspects of that decision are being revisited now and that we may get some changes in that decision.

[The information follows:]

To a large extent, fiscal year 1982 is a transitional year in our Technology Transfer program, in which our emphasis will move from applications of Landsat Multispectral Scanner (MSS) data to the technique development and testing of new improved Landsat-D Thematic Mapper (TM) simulator data. As a result, we will place more emphasis on the part of the Technology Transfer program which deals with the conduct of experimental test and evaluation of emerging new remote sensing techniques as compared to the broad based technology demonstration projects that we have conducted in the past.

The experimental test and evaluation thrust will consist of three specific activity areas. First, permanent test sites will be established in accordance with NASA's technical requirements and user needs, as a long range cost effective method for testing, evaluating and establishing state-of-the-art remote sensing technology and its utility in physically and culturally diverse user environments. Projects conducted at these test sites will address priority users resource information needs and will provide an opportunity for involvement and oversight by a network of user organi-

zations. Secondly, we will continue to conduct, on a selective basis, joint projects with Federal, state and local government agencies and private sector organizations on a one-to-one basis in their own test environments. The test environments will be selected to be representative and of interest to similar user communities. Technical workshops will be utilized to ensure broad dissemination of technology which has been validated through these projects. Thirdly, we will also continue to use universities sponsored by our University Applications program as a mechanism to develop, test, evaluate and transfer new remote sensing techniques to users.

These three activities will be funded at a level of about $2.5 million in fiscal year 1983. Approximately $1.0 million will be allocated for cooperative user projects and test site activities and $1.5 million for support of universities involved in remote sensing.

Mr. FLIPPO. The present plan of NASA is to phase out support for the development of an operational system and concentrate on R. & D. and improvements essentially?

Mr. KELLER. That is a fair statement, recognizing that there is an administration decision, actually from the previous administration, which as far as I know has not been changed, providing for responsibility in NOAA to operate any U.S. operational land observing system. So, regardless, NASA would not be planning for that activity.

Mr. FLIPPO. One of the things we are trying to get at here, I am trying to find some consistency in the approach, and I know that you are, too, and I wonder if it is consistent that the administration should plan to cease supporting the operational Landsat, and at the same time have NASA make a large investment at Goddard in a Landsat data analysis facility.

Mr. KELLER. Are you referring to Landsat?

Mr. FLIPPO. New equipment of about $14 million for new equipment at Goddard that I understood was there, is that not correct?

Mr. KELLER. I am not specifically aware of the $14 million number.

Mr. FLIPPO. Without arguing over the number, I believe you have before us a request for facilities at Goddard involving that and it just seems to me that that might be inconsistent.

Mr. KELLER. There are two categories of facilities at Goddard that you may be referring to and there may be some specific mission which could be why I don't recognize them.

Mr. FLIPPO. In this area I would appreciate if you would perhaps supply an answer for the record—the specifics of it which would help us understand it better.

Mr. KELLER. We will do that.

Mr. FLIPPO. Thank you.

[The information follows:]

At the Goddard Space Flight Center, there are two classes of Landsat facilities: data analysis and data processing. Both facilities are required in order to allow accomplishment of research related to the Thematic Mapper and the operation of the MSS. The Landsat Data Analysis Facility is used to characterize the performance of the Landsat-D instruments and to accomplish applications research to determine the incremental improvement of the Thematic Mapper (TM) over the MSS. The Data Processing Facility is used to process the raw instrument data into usable products.

Mr. BROWN. One additional question?

Mr. FLIPPO. Certainly.

Mr. BROWN. With regard to the planetary exploration situation, I presume that you can't give the committee any additional figures

on outyear budget plans until you have reviewed the work of the committee that has been set up under Dr. Hinners to look at the overall planetary program?

Mr. STOFAN. That is correct. The results of the committee's recommendations to NASA will be given consideration in the development of the fiscal year 1984 proposed budget for planetary exploration.

Mr. BROWN. That was my next question.

If you would be receiving and analyzing those recommendations in time to incorporate them in the next fiscal year's budget?

Mr. STOFAN. Yes.

Mr. BROWN. You do not have any, and you have said no one has already, you do not have any outyear plans which would limit the extent of the funding for the planetary program until you have reviewed this study?

Mr. STOFAN. Yes, that is right. The budgets tend to be a runout of an existing program and that is generally what your plan is, to live at those levels in future years. But the budget process, as I have learned, really works 1 year at a time. Fiscal year 1984 is another year. I am sure Burt and I will come back to Jim and to others with a host of worthwhile scientific and applications programs to consider.

Mr. BROWN. You have not been told what reception you will get from OMB yet?

Mr. STOFAN. No, I have not been told.

Mr. FLIPPO. One final point, gentlemen.

The Committee last year authorized $9 million to continue technology transfer activities, and in the second paragraph you indicated that you intended to phase those out.

I wonder if you would have any suggestions for the Committee as to how we might make clearer our intent in regard to that matter? [Laughter.]

Gentlemen, I deeply appreciate your testimony today, and we look forward to working with you in the future.

[Whereupon the subcommittee adjourned at 3:45 p.m. subject to the call of the Chair.]

1983 NASA AUTHORIZATION

TUESDAY, FEBRUARY 23, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2325, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Nelson, Winn, Hollenbeck, McGrath, and Lowery.

Mr. FLIPPO. The committee will come to order.

Today the Subcommittee on Space Science and Applications will continue hearings on NASA's fiscal year 1983 budget request by receiving testimony from representatives of organizations outside NASA. While we realize the need for realistic Federal budgets, we need to understand the implications and impacts of Federal funding for research and development.

We welcome our witnesses today and we look forward to their various viewpoints and perspectives of the Nation's civil space program.

Our first witness is Mr. Norman Augustine, vice president, public policy, American Institute of Aeronautics and Astronautics. He is accompanied by Mr. Stan Rosen, chairman of the Space Systems Technical Committee.

Following Mr. Augustine will be Mr. Theodore Simpson, chairman of the Space Subcommittee, Institute of Electrical and Electronics Engineers, and for our third and final witness we have with us Dr. Mark Chartrand, executive director, National Space Institute.

Mr. McGrath, the gentleman from New York, do you have any opening statement that you would care to make at this time?

Mr. MCGRATH. I have no opening statement.

Mr. FLIPPO. I understand Mr. Hollenbeck has an opening statement which will be included in the record.

[The opening statement of Mr. Hollenbeck follows:]

OPENING STATEMENT OF HON. HAROLD C. HOLLENBECK

Thank you, Mr. Chairman. I look forward to the testimony of our witnesses who represent a number of highly informed individuals outside of the NASA network. The past contributions of the American Institute of Aeronautics and Astronautics, the Institute of Electronic and Electrical Engineers, and the National Space Institute to this committee have helped all of us gain some insight into how the working aerospace engineer or even the interested layman perceive the functions of NASA and this subcommittee.

I am particularly interested in finding out about the concerns expressed by the members of each of these organizations over the civilian space program. Is NASA still viewed as an agency with an adequate role in space? Is the militarization of outer space a current issue being discussed by AIAA, IEEE, and NSI members?

As you know, the White House Office of Science and Technology Policy is working on a report that will address national space goals for the near future. I ask, will the conclusions to the OSTP study fall in line with what the members of these representative organizations believe should be our near term goals in space? Or will the White House issue a space policy paper that ignores the "grass roots" aerospace concerns? Let us hope that there is good communication between the Administration and our aerospace membership and technical societies. I commend the activities of the AIAA, IEEE, and NSI and I look forward to their noteworthy contributions to this Subcommittee.

Thank you, Mr. Chairman.

Mr. FLIPPO. Without objection, permission for photographs is granted.

Mr. Augustine, we would be delighted to have your testimony. If you wish, we certainly will include your full statement in the record immediately following your oral presentation. Please feel free to summarize if you deem it appropriate.

STATEMENT OF NORMAN R. AUGUSTINE, VICE PRESIDENT, PUBLIC POLICY, AMERICAN INSTITUTE OF AERONAUTICS & ASTRONAUTICS, ACCOMPANIED BY DR. STANLEY G. ROSEN, CHAIRMAN, TECHNICAL COMMITTEE ON SPACE SYSTEMS

Mr. AUGUSTINE. Mr. Chairman and members of the subcommittee, we would like to submit a rather in-depth statement for the record, as you suggest. We will provide that to the reporter.

Mr. FLIPPO. Very good.

Mr. AUGUSTINE. I want to begin, as we do each year, by thanking you and the members of the committee for affording the AIAA the opportunity to share with you our views on the proposed fiscal year 1983 NASA budget.

As you know, the AIAA is an organization, a professional society, comprised of 30,000 individual engineers, scientists, managers, and students working in all the disciplines relating to space and aeronautics.

I would propose to give a very brief overview of our statement and to call upon Dr. Rosen, who is the chairman of our technical committee on space systems, to discuss space science and applications. Then when he is finished, I will give a brief summary. In total, I believe we will take about 10 minutes, if that is acceptable to the committee.

Mr. FLIPPO. That will be fine. Thank you.

Mr. AUGUSTINE. It is appropriate, we believe, that we appear before you this year during the annual observance of Engineers' Week. This year the theme of the week is "Pioneering America's Revitalization," a topic which is perhaps especially fitting when we discuss the activities of NASA.

As we have mentioned on a number of occasions in the past when we have appeared before you, it is our belief that the NASA programs are essential to the future prosperity and security of the United States and, indeed, serve to benefit all mankind.

We obviously are strong proponents of space activities. At the same time, we also hope that we are reasonable and responsible

citizens and recognize the need to take a balanced view of the Nation's fiscal problems.

We are pleased in general with the proposed program that has been submitted by the administration this year. Given the economic realities that we face today, any program that generally keeps pace with inflation must be considered to be at least a reasonable expectation.

Nonetheless, given the relatively suppressed level of last year's NASA budget, which is used very often in comparing this year's request, one can find reasons for concern in some specific areas of the fiscal year 1983 funding.

We would also note, as indicated in some of the recent Department of Defense studies of the inflation indices that apply to high technology endeavors, that those indicators peculiar to the space program are considerably higher than the Consumer Price Index. Therefore, a budgetary growth of 10.6 percent is not necessarily a cause for rejoicing.

At the same time, we do, as I say, appreciate the need to constrain all Federal expenditures until our economy is again under reasonable control. We would, though, caution strongly against further reduction of NASA's budget. The belt is already, in our judgment, very tight.

At this point I would like to ask Dr. Rosen to speak to the space science and applications program. When he is finished, I would like to talk a moment about space policy.

Dr. ROSEN. Thank you.

As chairman of the Space Systems Technical Committee, I was able to compile a good cross section of AIAA belief and opinion about the proposed budget. Specifically, I would like to address two areas. One is space science and the other deals with specific aspects of the space applications program.

Last year our principal comments to this committee focused on the anticipated demise of the NASA space science program. Of course, we are very happy to see that that end did not come, and the space science program is fairly strong.

We have good support for such programs as Space Telescope, Gamma Ray Observatory, Spacelab Payloads, Galileo, and ISPM, which is the International Solar Polar Mission, et cetera. We are happy that these programs are being supported.

However, the continuation of the planetary program is also a vital element in the overall space science strategy and, of course, is a major factor in international science cooperation.

Our recent letter—that is, the AIAA's recent letter—to the Administrator of NASA criticizing the termination of the U.S. spacecraft in the International Solar Polar Mission was motivated in large part by the serious effect such a move has on the credibility of the United States as a partner for international cooperative ventures. Such cooperation is an appropriate and an effective way to control the cost of science programs which do, in our opinion, benefit all mankind.

But now the planetary exploration budget is dropping 24.6 percent from fiscal year 1982. The devastation of this program is an act that is occurring without, we feel, adequate policy guidance. This budget will result in a disbanning of research groups, the clos-

ing down of operating spacecraft, and a waste of data for lack of analysis. This adds up to lost capabilities and mixed opportunities.

We would also point out that the cancellation of future planetary exploration projects has momentous implications for the future of our program for in situ exploration of extraterrestrial bodies. We hope that the planetary exploration program might be sustained in some austere form. We concur with Dr. Beggs' testimony before this committee: The time has now come to reevaluate our planetary program to set a new direction for the future.

We believe the current studies in this area could lead to the development of less expensive missions for the late eighties and early nineties as well as for more ambitious manned missions in the future. Specifically, the AIAA believes that the time has now come to consider resuming detailed investigations of our own Moon. Although we walked on the Moon and have ridden on the surface of the Moon, we obviously understand much less about the Moon than we do about the Earth. Many square kilometers of lunar surface are uncharted and many challenging, scientific mysteries remain.

Now to turn to the area of space applications, which, by the way, is an area which provides the nearest term payback to our economy and to the strength of our national security. Of course, the administration is seeking to transfer mature capabilities into the private sector. We support this strategy, but we are very concerned about the resources committed to the applications program in general.

Our comments for the record discuss portions of this applications program, specifically the Earth resources, remote sensing, the environmental observation program, and the materials processing program.

However, I would specifically like to discuss the communications applications area because here NASA's fiscal year 1983 budget is of most concern to us. Last year NASA presented a budget that supported their planned reentry into the satellite communications technology leadership role. Unfortunately, the proposed NASA fiscal year 1983 budget is simply inadequate for the continued development of even key component technologies and can only be interpreted as a going-out-of-business budget for communications.

Since 1976 AIAA has strongly supported the need for NASA to fund technology development and demonstration in the field of satellite communications. Last year we again testified to this committee in support of NASA's program. In particular, we recommended that you support the 30/20 GHz program.

The rationale for this recommendation remains sound today. The need for NASA leadership is even greater. Communications and information systems are key technologies of the post-industrial age that we are now entering and are already an arena of intense international cooperation.

History has shown that for very understandable reasons the communications industry alone cannot, has not, and will not provide adequate support for the advanced work needed now to support space communications system of the 1990's. This type of activity, which is being aggressively supported by European and Japanese governments, must be matched by a NASA lead effort if we are to maintain our pre-eminence in this important world market.

Now I want to reiterate at this point our view that the administration's goal of moving the applications program to the private sector is sound. The immediate task is to identify and help resolve obstacles through effective and timely transition while maintaining adequate technical support in the interim. Hasty or poorly planned actions here can have a significant adverse effect on our Nation's economic, political, and military strength in the next decade.

Thank you.

Mr. AUGUSTINE. I would like to make a few remarks about the space transportation system, which certainly is, at least in a fiscal sense, the centerpiece of the NASA program.

As the STS moves nearer to an operational status, we believe that particular attention needs to be devoted to organizational and operational practices which will increase the flight rate and reduce the operational costs, so that we might get the most out of that system.

We also have noted that the administration did not request long-lead items for Orbiter 105. We would recommend it as a good investment, and suggest it even for orbiter 106.

To operate a four-vehicle fleet, we believe, would be somewhat risky, and it probably falls short of the traffic model that is mostlikely to occur. To introduce a break in production would be very uneconomical in the long run.

We also believe that it is time to start putting the STS management on a truly operational footing. Regardless of who actually operates the STS program, it clearly should be someone who is dedicated to operations, and not development, and is responsive to the needs of all users.

We are particularly impressed with some of the unique Shuttle capabilities that we have an opportunity to demonstrate. We would lend our strong support to the planned in-orbit repair of the Solar Maximum Mission, which affords a chance to demonstrate a truly unique Shuttle-based operation.

Also relating to the Shuttle is the need for more energetic upper stages to permit full exploitation of the Shuttle's capabilities. That is an area that we believe deserves the committee's particular attention.

With respect to space goals, we have seen in the 1950's a clear national goal to establish an artificial Earth satellite; in the 1960's, the Apollo program; in the 1970's, the STS; and in the 1980's we find ourselves without a clear major national goal in space. We are not suggesting another crash program similar to Apollo. We do believe a sustained, long-term commitment that we pursue with a considerable degree of perseverance is in order. Such a goal might consist of a near Earth platform that would eventually evolve to manned habitation.

We are dismayed by actions in the preparation of national space policy that appear to us at this point to focus more on how to cut back the civilian space program. We think we should instead look ahead to establish specific goals, prioritize those goals, and then develop programs to reach them efficiently.

The budget process, we believe, is a poor way to establish policy. We would encourage, first, the establishment of policy and goals

and, second, dealing with priorities and budgetary issues that match those goals.

The Nation, of course, is entering a period of considerable historical importance when we recall that 10 years from now we will be observing the 500th anniversary of Columbus' voyage to the New World. The decisions that we make today and in the year ahead will have a good deal to do with the status of our space program in that year of the occasion of the 500th anniversary. We believe that it is possible to have a program that will encourage the prosperity and the security of the world in which we live and also lead to a number of very exciting adventures.

Mr. Chairman and members of the subcommittee, that completes our formal statement. Dr. Rosen and I will welcome your questions.

Mr. FLIPPO. Thank you very much. Your testimony will be very helpful.

Inasmuch as all of our witnesses today are discussing the same general area, and it is a very important area for consideration, I believe we would like to take the testimony of the other witnesses. If you gentlemen could remain with us, I think the committee will have questions at the end of the testimony.

Mr. AUGUSTINE. That will be fine. Thank you.

Mr. FLIPPO. At this time, then, we would like to receive the testimony of Mr. Theodore Simpson, chairman of the Space Subcommittee, Institute of Electrical and Electronics Engineers.

We are pleased to have you with us. We will, of course, take the entire statement for the record. It will be included in the record immediately following your oral presentation. Please feel free to summarize as you deem appropriate.

STATEMENT OF THEODORE R. SIMPSON, CHAIRMAN, SPACE SUBCOMMITTEE, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

Mr. SIMPSON. Thank you, Mr. Chairman.

Since I have a brief statement, I would like to read in its entirety.

I am speaking today on behalf of the U.S. Activities Board of the Institute of Electrical and Electronics Engineers. The Institute was founded in 1884 and is the world's largest technical society with 215,000 members worldwide. The U.S. Activities Board represents the 165,000 IEEE members who reside in the United States.

During 1981, I was an IEEE Congressional Fellow, and I served on the staff of the Senate Subcommittee on Science, Technology, and Space. It was my responsibility to cover the entire civilian space program for the Democratic members of the subcommittee. As a consequence of this, I attended most, if not all, of this subcommittee's hearings on the NASA budget, remote sensing, communications satellites, and future space programs.

I would like to commend the members and the staff of this subcommittee for the outstanding job that they are doing in reviewing NASA's performance, and of keeping the public informed of the problems and opportunities associated with the civilian space program.

During the past century, science and technology have come to play an increasingly important role in our daily lives. Our standard of living and our very survival as a free nation rest upon our willingness to use science and technology for our benefit. This is true in general, and it is certainly true about our use of space.

We believe that NASA has played a key role in advancing our Nation's science and technology, and that it should be encouraged to continue to do so in the future. This country was not built by those who waited and rested and wished to look behind them. This country was developed by those who moved forward, and so will space.

An agency such as NASA moves forward by the start of new programs—without this it will stagnate. We are dismayed at the continuing cutback in the scope of NASA's tasks, and the resultant problems that this has caused in the scientific and technical communities. Funding for NASA should not be viewed as just another line item in the Federal budget, but rather as an investment in our Nation's future.

Our Nation's aviation industry, which began with two brothers in a bicycle shop in Ohio, is today a $100-billion-a-year industry. Similarly, our space industry, which started out in a cabbage patch in Massachusetts, has already made a substantial contribution to our daily lives, and this contribution will continue to grow. With this potential in mind, it is in our best interest that funding for NASA be stabilized in the years ahead and, if possible, increased in selected areas to make up for lost ground and to insure our preeminence in space.

I would now like to briefly give you our view of where NASA is today and what we would like to see it do during the next decade. Then, I would like to discuss in more detail our major problem with the fiscal year 1983 budget—the lack of adequate funding for communications satellite R. & D.

We were delighted with the two successful orbital test flights of the Space Shuttle last year, and are confident that the remaining two test flights and the first operational flight will be equally successful this year. The Fourth of July this year may be particularly spectacular if the last test flight proceeds as planned.

We believe that NASA should be allowed to develop the basic capabilities needed to expand our use of space and to reduce the cost of operating there. This will enable the United States to gradually increase the size of its operations in space in the years ahead. We support the extension of the Shuttle's capabilities by the development of a reusable orbital transfer vehicle and a space station, and we are glad to see that the planning for these capabilities is continuing.

NASA also plays a vital role in the development of our commercial use of space by doing the long-term, high-risk R. & D. which private industry cannot afford to do. This is true not only in such budding industries as manufacturing various materials in space and civil land remote sensing, but also in the more mature industries of aviation and communications satellites. Quite simply, if NASA does not do this research, then it is not likely to be done in the United States, and we will cease to be a leader in another

major commercial area because the Europeans and the Japanese are willing, and indeed are now making, this investment.

Underlying our increased use of space is the need for knowledge about the solar system and the universe beyond. We thus support the continued exploration of space, in general, and particularly such projects as Galileo, the Venus orbiting imaging radar, and the space telescope.

To date, much has been learned about the universe through NASA's efforts, but the major fruits of NASA's space science program remain to be harvested. One mission of an orbiting astronomical observatory operating in a new wavelength, like one flyby of Saturn, is barely sufficient to pose the next level of important questions which need to be answered. This exploration should continue into the 1990's. It would be sad, indeed, if we were to celebrate the 500th anniversary of Christopher Columbus' landing in the New World in 1992 without a continuation of our exploration of space.

One area that was conspicuously neglected in the fiscal year 1983 NASA budget was the initial funding for a 30/20 GHz communications satellite flight demonstration. We believe that Congress should add $25 to $30 million to the budget for this purpose in order to assure continued U.S. preeminence in this important commercial area.

Starting with the Syncom series of spacecraft, which established the feasibility of using the geosynchronous orbit for communications, the United States has led this field for many years. NASA developed a significant in-house expertise, funded the development of new technology by several U.S. contractors, and played a leadership role in making this a uniquely U.S.-dominated field.

In late 1972, the Nixon administration thought that the industry had matured to the point where it could support its own R. & D. needs and decided that NASA should not initiate any communications satellite flight programs beyond the sixth applications technology satellite (ATS-6).

As a result, the funding for such programs, which had ranged between $80 and $120 million per year, in 1981 dollars, over the period 1962-74, was sharply reduced to approximately $10 million per year. The reduced amount was just sufficient to allow operation of ongoing experiments, low-level technology development, and limited system concept studies.

Europe and Japan were quick to fill the vacuum left by NASA's withdrawal from communications satellite R. & D. as evidenced by their increased investment and rapid rise to leadership in several communications satellite technologies. Even more important is the fact that European and Japanese manufacturers are moving from the fabrication of components to the fabrication of subsystems and complete systems, and changing their roles from that of subcontractor to prime contractor.

By 1978, various committees, technical societies—including the IEEE)—and Government organizations proposed that NASA resume communications satellite R. & D. In the process, more than 100 private and Government entities, representing a wide range of interests in communications satellites, provided inputs to NASA's decisionmaking, and its planning for reentry into the development

of communications satellite technology. Continued NASA support of 30/20 GHz technology development was endorsed by representatives of all of these groups and the 30/20 GHz program became the principal element in NASA's R. & D. effort in satellite communications. In October 1978, the Carter administration indicated that U.S. leadership in communications satellite systems would be supported by NASA.

Last June, Western Union released a report which indicated the continued growth in the need for communications satellites in the future. It estimated that the worldwide communications satellite market would be $35 to $50 billion over the next 20 years. The U.S. market alone was estimated to be $16 to $20 billion during this time period.

Shortly after the report was issued, this subcommittee heard testimony from a number of industry and Government witnesses on the importance of NASA's 30/20 GHz program, and of the need to begin the flight demonstration program in the near future if we are to maintain our preeminence in this area.

Since then, the Reagan administration has indicated its belief that private industry should do the long-term, high-risk R. & D. in this area, and it has not supported the proposed 30/20 GHz flight demonstration. We believe that the Reagan administration is wrong on this issue, and that this is a proper activity for NASA. Industry cannot afford to do the high-risk R. & D. necessary to maintain U.S. leadership due to:

1. The large investment required and the 8-to-10-year period before significant returns on that investment can be expected; and
2. The current high interest rates which reduce the incentive to invest in high-risk areas.

We would also like to point out that the lack of Government funding for long-term, high-risk R. & D. that industry cannot afford to do is not limited just to communications satellites. Another example is the Reagan administration's reduced support for NASA's aviation system technology program. OMB eventually hopes to phase this program out entirely. Once again, the Reagan administration is relying upon industry to do the R. & D. necessary to maintain our leadership in another important commercial field, and once again industry witnesses testifying late last year before the House Subcommittee on Transportation, Aviation, and Materials indicated that they were unable to do so.

Once flourishing U.S. industries in consumer electronics, steel, and shipbuilding are now largely lost to foreign competition. The automobile industry appears to be on the same slippery path. The communications and aviation industries are two increasingly rare examples of international U.S. leadership, now under challenge, which contribute importantly to the national economy, employment, and the balance of trade.

In addition, they are an important part of the industrial and technological base needed for the military security of this country. We believe that NASA must continue to do the high-risk R. & D. in these areas in order to forestall further inroads from foreign competition.

Thank you.

Mr. FLIPPO. Mr. Simpson, thank you very much. That was a very thorough statement.

We would like now to receive the testimony of Dr. Chartrand.

STATEMENT OF DR. MARK R. CHARTRAND, EXECUTIVE DIRECTOR, NATIONAL SPACE INSTITUTE

Dr. CHARTRAND. Thank you, Mr. Chairman.

It is pleasure to return to speak from a slightly different perspective than the previous speakers have. I hope, and I think that the public polls do show, that the National Space Institute does rather speak for the public interest rather than simply the engineering community, as important as that is.

I think we should recall that just 20 years and three days ago a distinguished gentleman who works on the other side of the Hill was shoehorned into a tin can and sent aloft for three orbits. An awful lot has happened in that period of time. In that period of time there has been increased public interest and the National Space Institute was founded about 8 years ago to speak for the public as part of the pluralistic and democratic input that the Government receives. Just within the past year or so polls by the University of Chicago, New York Daily News, Harris, AP, and NBC have shown that the public strongly supports the space program and, what is even amazing to me, that 42 percent of the people are even willing to fly in the Space Shuttle given the opportunity. I am not sure you could have gotten that kind of response about airplanes this soon after the Wright brothers.

But I want to say that I think one thing we really are missing is a goal, and I look forward very much to seeing what Dr. Keyworth's office comes up with in way of a national space policy. I think the importance of a goal is extremely important for the space program of this country, and I think this decade is going to be extremely important to our country in the space program.

I think that the committee has expressed a very proper concern about keeping a separate civilian agency and separate civilian programs. Mr. Beggs commented specifically on that and I think that we should keep in mind the importance of having a civilian space program in fact, as well as in name.

One thing that has happened over the past 20 years that has perhaps not become obvious to the public is that it is now simplistic to speak of simply the space program. We really have at least three, and they should not be treated equally. We have space transportation, we have applications, and we have science.

Applications is something where we should try to make the proper distribution of effort between industry, where appropriate, and Government, where appropriate. I think perhaps all the debates are going to come as to drawing that line of appropriateness.

As the transportation—just about everyone, I think, agrees that NASA should get out of running the bus company once the bus is ready to run. I am not sure that they have paid enough attention to that transition.

And as for space science, science has to be done for its own sake because we are interested in knowing our cosmic origins. I am an astronomer by training but I'm just speaking as a representative of

the public that the need to explore and learn about the universe is something very important to all of us. It is something the public can't pay for by subscriptions, as some people have suggested. I submit that you don't run airports by charging admission to the observation deck.

We do have a few specific concerns about this year's NASA budget that I think deserve quite a bit more attention. One is why we are not doing a 30/20 gigahertz communication satellite and the Japanese have been able to do it seemingly very easily. I think we should spend more time looking beyond Landsat D-Prime, because I have the feeling that this Nation is dropping the ball on remote sensing. We are still concerned about the lack of U.S. participation in ISPM, both because of its science implications and because of its foreign policy implications; and we do support the acquisition of a fifth Shuttle, or at least keeping our option by getting those long leadtime items.

The NASA budget increase of about 11 percent this year is heartening, but three things particularly should be kept in mind.

One is that it is an increase over an already inadequate budget, therefore, we shouldn't be too heartened. The heartening part is simply that it is up; that is at least the right direction and something we haven't seen, at least not that much, for a long time. It may be interesting just to note that the entire NASA expenditures from its foundation in fiscal year 1959 to 1981, expressed in 1981 dollars, is only about 60 percent of this year's DOD request—over the entire lifetime of the agency. And we also need to keep in mind because of that 11-percent increase it attracts attention to itself and we should not let the few critics that are around use that as a reason to reduce it from its already marginal level.

Government has a long and fruitful history of investment in the future of the country, and the economic implications and the foreign policy implications are extremely important. We today benefit from those previous expenditures.

One thing that the National Space Institute is particularly concerned about is the education and information transfer aspects of the space program. Some of those information transfer budgets have been zeroed out, others have geen reduced, and education—I guess I can only say right now what is in danger. I hope that a number of things come about that allow NASA to continue its education activities because that is an important part of maintaining our future in space, both for education and for maintaining the interest of the people who are going to work in our space program, and some of them in space within the next decade. It is a critical time. We can lose our lead in the 1980's to the other nations. And over the past history of NASA there have been a number of critics who have said that spending money on space is a waste of money. Well, if we drop the ball now we will have proved them right. I don't think we can do that.

Mr. Chairman, that concludes my oral remarks, and with your permission I would like to have the full statement included in the record.

Mr. FLIPPO. We shall certainly include the entire statement in the record. Thank you very much for your testimony.

If the other witnesses might join back at the witness table, we will have a discussion.

The subcommittee has announced a policy in the past of recognizing members as they arrive at the hearing. I hope that is acceptable with the gentlemen, and if that is acceptable with the gentleman, I would recognize the distinguished Congressman from New York, Mr. McGrath.

Mr. HOLLENBECK. Mr. Chairman, may I have unanimous consent to have my opening remarks included in the record?

Mr. FLIPPO. Without objection, the statement of Mr. Hollenbeck will appear at the beginning of the hearings, following my opening remarks.

Mr. McGrath.

Mr. MCGRATH. I only have one question, Mr. Chairman. There seems to have been a comment seen throughout the testimony of the witnesses. This was the necessity for the inclusion of the 30/20 gigahertz communication satellite flight demonstration. I am just wondering to what is the extent of this as opposed to some of our other priorities.

Mr. SIMPSON. Well, when I reviewed the budget one of the things that struck me was the fact that it was left out entirely. There is funding for other things in the budget, and I think it should be included.

You might want to stretch it out a little, but I think from the testimony that was given last July to this subcommittee that it was very important and that time is running out. If you don't begin it soon we are going to lose our competitive edge in a very important area.

In fact, I would like to point out that the communications satellite area is the only commercial area in space that is making money, has made money in the past, and will make money in this decade. It is an important area to maintain.

Mr. MCGRATH. I think at that time there was some discussion as to whether or not it would be cheaper for us to buy the technology instead of developing it. Is there any thought on that particular aspect?

Mr. AUGUSTINE. Sir, in regard to your first question, first of all it is not only the flight demonstration which we feel is in jeopardy but also the technology development. There is really going to be a low level and there are a number of key technologies that have to be developed on a time scale consistent with industry's needs to field an operating system. So we are concerned both about the technology development as well as the flight demonstration. And my personal feel with regard to your second question about priorities is that this kind of application has such high leverage in the near term that you have to look hard at some of the other programs in the NASA budget, or even outside the NASA budget, to find ways to fund that. It really justifies tough scrutiny of the entire budget.

Mr. FLIPPO. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Mr. Augustine, I didn't hear the first part of your testimony and I apologize for that. I did come in when Mr. Rosen was saying that we should do more exploration and more detailed investigation of the moon. Do you concur with that?

Mr. AUGUSTINE. I do indeed. In the formal statement that we submitted we pointed out that our exploration of the moon, although very impressive is, nonetheless, really a mere beginning. The major portion of the Moon, which there is reason to believe is somewhat different from that which we have seen, remains to be explored.

I might ask Dr. Rosen to elaborate a bit on his comments.

Mr. ROSEN. Sir, as you know, one of the options that NASA is studying for continuation of planetary exploration does involve the Moon, and they are in agreement with our recommendation. To elaborate on what Mr. Augustine said, for some time they have proposed a lunar polar orbiter to take a look at some of the areas that don't receive direct sunlight to see if there is any entrapped water in that area, or perhaps other things we haven't seen elsewhere. And there are many areas of the Moon we haven't explored, even though we have landed in a few isolated spots.

Mr. WINN. Would you say—we are talking about exploration now. Would you think that there could be some additional work done in the science field on the Moon, or are we talking about exploitation?

Mr. ROSEN. No, sir, I am talking principally about just understanding the moon, and that is science.

Mr. WINN. OK.

Do you think under the present budget stress that you could help us get that through Congress, because I don't think we could?

Mr. ROSEN. Sir, when you talk about what the alternatives are, and here again we are talking about the long-term space science program, this would be an alternative, for example, to a more ambitious program to go to outer planets and other missions which might be more expensive. So as a way of constraining the planetary exploration budget this looks like an attractive alternative.

Mr. WINN. What efforts, Mr. Augustine, do you have—does your organization have planned for this year, particularly as far as regarding NASA's technology transfer and technology utilization?

Mr. AUGUSTINE. I am glad you asked that particular question. The AIAA began, as you probably are aware, several years ago to establish a program of cooperation between the AIAA's corporate members and other major firms in the Fortune 500 that are not primarily aerospace oriented.

Mr. WINN. We applaud that action, too.

Mr. AUGUSTINE. We appreciate your comment. It has been a rather successful program. Our objective was one of trying to help NASA to convey some of the technological opportunities that have come out of the space program to other fields. Some of the most advance technology on the Earth today, in my personal judgment, has come from the space program, and yet one of the inhibitants to its use by companies in more everyday fields has been their lack of knowledge of it, their lack of familiarity with it. So our program is not aimed particularly at creating new technology but rather at taking that which is readily available and helping other people understand it and apply it. We have had good response from the companies that are associates in this effort and we look forward to a promising time ahead.

Mr. WINN. Have you any discussions at AIAA, at board meetings, or general sessions, dealing with the possibility of the free enterprise system somewhere taking over the operation of the Space Shuttle when it becomes operational?

Mr. AUGUSTINE. We have indeed. We discussed that in some length. We are not prepared to recommend to you some specific agent to operate the Shuttle. I believe we are prepared to suggest that whatever agent it is should meet a couple of standards. One of those standards would be that the agent is not primarily development oriented. Having people with a principally development-oriented background conducting an operational program usually results in added costs, because engineers are in the habit of continually redesigning to make the product better and better, when what we need to do is make it cheaper and cheaper and get on with its use.

The second standard that we would suggest is that this operating agency or entity should not also have responsibility for performing fundamental research and development. The burdens of day-to-day logistics support of an operational system are such that they tend to draw away from your ability to conduct research that has long-term payoff. The time costs and the pressures are very long term. That makes the research no less important. It does make it more difficult to pay attention to when you have day-to-day operating pressures.

So we would encourage getting on with the transition of the Shuttle to a purely operational organization, a stripped down, tough, lean entity. And whether that be a part of the Government, or private industry, or a coalition, or what have you, we think that is a subject that hasn't been explored well enough yet for us to be able make a competent recommendation.

Mr. WINN. My last question, Mr. Chairman, and I thank you for recognizing me.

I would like to ask each one of the gentlemen, all four of them, if you were sitting up here and if you thought that somewhere you probably were going to end up with the budget that the President recommended, or possibly something a little bit less, what would be your top priorities?

Mr. SIMPSON. You mean to cut?

Mr. WINN. Top priorities to fund.

Mr. SIMPSON. Assuming that you had the money, I would add $25 to $30 million to begin the 30/20 flight demonstration program. I recognize that this is a period of austerity and the problems you have, because I faced the same problems last year. I hope you don't have to spend all of this year working on the budget like you did last year.

Mr. WINN. Amen, we might.

Mr. CHARTRAND. I would agree with Mr. Simpson. If you could add budget, which you probably can't, I think the 30/20 gigahertz is very important; I also would like to see funding restored for public education and information transfer programs which have been reduced. If you can get away with only what has been proposed I think that this is a budget which you can live with. As it is at least it leans in the right direction, but it would be very, very difficult—I think the important thing that has to be kept in mind

is that this is still a marginal budget for the Nation's space program.

Mr. AUGUSTINE. Since you didn't place a limitation on me I would mention four programs for your consideration. One I would share the comments on the 30/20 gigahertz activity. Second, I would mention the need for an energetic upper stage for the STS. Third, I would commend your attention to long-lead funding for an additional orbiter; and, last, I would raise a somewhat different area that we believe has been neglected; that relates to the liquid propulsion industry in this country which is in danger of—I was going to say drying out which would be a bad pun. But it certainly is in danger of decreasing to the point it is below a critical mass.

The second of the comments I made might help that area, but we believe particular attention is needed to try to better fund that particular sector.

Mr. ROSEN. Rather than repeating those comments, let me put some context around it. The first priority in my mind would be to insure stability of existing programs. I think this is true across the whole space program. We don't have room for stops and starts. Once we have a program commitment like the Shuttle, like Galileo, like Space Telescope, regardless of the absolute priority at any given time we need to have stability in that program to insure continuity so that people can count on having a program that works, and it can be brought home within a reasonable budget. That would be my first priority.

Then I would put priority on applications, because applications really, again, brings home the butter in the nearest term, and certainly 30/20 looks like a key candidate there.

My next priority then would be technology development, that is the next generation of systems beyond immediate application and that would be, of course, the Shuttle, which we have seen, as well as the upper stages and the planning for the orbital terminal to which the Shuttle can dock and operate to extend its operation in orbit.

And then the final priority, which is not to say it is unimportant, but in my list of priorities would be the space science area which has the longest term payback.

Mr. WINN. Thank you.

Thank you very much, Mr. Chairman.

Mr. FLIPPO. Thank you.

Mr. Hollenbeck.

Mr. HOLLENBECK. Yes, sir.

You answered Mr. Winn with regard to technology transfer and I am sure you are all aware that we authorized some $9 million last year in the NASA budget for that and they are using that funding this year to phase out that program. I wondered if in light of that AIAA, or are you aware of any other groups that are planning extra effort in that area, the area of technology transfer, this year or in the coming year?

Mr. AUGUSTINE. Mr. Hollenbeck, I am not aware of any particular activities other than those conducted by the AIAA. Maybe some of the other gentlemen at the table would be. We do plan several coordinated meetings and working groups with our nonaerospace

corporate associates during this year, and we feel the need to take up some of the slack that obviously is going to be created.

Mr. HOLLENBECK. Well, I think what concerns me, and some of us on this subcommittee, is whether or not the private sector can take up that slack in the area of technology transfer and certainly applications.

Could you comment on that?

Mr. AUGUSTINE. Well, it is very ironic in the sense that one might ask why, if this technology is so good, does it require so much assistance in getting transferred. You would think that the recipient would be very eager to take that on. I might say, as a person from industry myself, with a company that has both an aerospace segment and a nonaerospace segment, that it is very, very difficult to take the sort of basic technology that comes out of aerospace and apply it immediately to the commercial marketplace. The investment cost, the time is very, very great, and it is hard for most companies that have to face a profit and loss statement and return to their stockholders a profit each and every year to make long-term investments. That is unfortunate, but it is somewhat characteristic of the economic environment in which companies operate in this country. So although I, like many of my colleagues, am very fast to criticize overly restrictive Government constraints and regulations, I realize at the same time that we badly need the Government's assistance in long-term endeavors that no one of us can afford to take upon ourselves. And, furthermore, if each of us could afford it it would be a terribly inefficient way for this Nation to compete with our allies and our business competitors in other parts of the world.

Mr. HOLLENBECK. Thank you. Someone mentioned the current administration's activities attempting to define a national space policy for the next 10 to 20 years. Would each one of you comment on the Nation's goals in the civilian space activities for the next 20 years.

Mr. SIMPSON. Mr. Hollenbeck, I guess I would start off by saying I hope that it is a balanced space program which includes not only such basic capabilities as a Space Shuttle, a space station and an orbital transfer vehicle, but also the continued exploration of the solar system and the universe beyond, and the expansion of our commercial use of space.

Communication satellites are obviously going to play a big part in our commercial use of space in the next 20 years, and NASA should do its part to make sure that the United States remains in the lead. Remote sensing would be another area which I hope would also become commercially important.

Mr. CHARTRAND. Let me first absolutely agree that it should be a balanced program, that science is as important as applications. And I would also say that space science is one of the areas of pure research in this country that is most spectacular, most attractive to the public. But I think that one thing that many of our members, and a good part of the general public would support, is that eventually we are going to have some kind of manned presence in space. I think it has the advantage of a goal which is evolutionary rather than, like the Apollo program which perhaps is said be the price of success. It was too concrete. We set goal, we did it, we stopped. The

concept of growing effort in space I think is one that the permanent manned station—whatever you want to call it, however that evolves—is one that I hope NASA turns its attention to, and I hope that it comes out in the space policy study.

Mr. HOLLENBECK. Thank you.

Mr. AUGUSTINE. My hope would be that our space policy would once again find a centerpiece around which we would focus our efforts. The best centerpiece in my opinion would be the evolution toward a manned platform of some type, not something that we do overnight with enormous amounts of money but something that we do with some preserverence.

At the same time, I would hope we would not neglect some things that have a much less obvious payoff but are from a scientific standpoint extremely significant. The exploration of the planets would be perhaps one of the greatest examples of that type of an endeavor.

I would footnote my comments by noting that the rather considerable amount of its national treasury that the Soviet Union has devoted to their manned space program suggests that they believe there are significant payoffs in that area, and I would hope that we would not find ourselves falling far behind the magnitude of their effort.

Mr. ROSEN. Again I would like to echo what the previous gentlemen have said, that a balanced program is certainly essential. And I refer to balance not only between the various aspects of the civil space programs: science applications, et cetera, but also between the military sector, the commercial sector, the scientific sector, the other civil sector we haven't talked about that resides in NOAA—there are a lot of space programs around. And together these form an integral part of our American way of life now in terms of economics, security, etc. We need balance in our overall activity, and yet each of these elements has to work together and the teamwork makes the whole thing work. The NASA that we now have is the cement that holds that team together because of its ability to develop advanced capabilities; so that NASA has to be a centerpiece of that policy consistent with the 1958 Space Act, the chartering legislation.

Second, we need to have a long-term commitment in that policy to the importance of these space activities. It is not a flash in the pan any more; we are going to be there, we are going to be developing things for a long time. We don't need spurts and starts. The space program, to be integrated, must be a long-term facet of American activity. That should be recognized by the administration and appropriately supported.

Then we need the administration to recognize that the national policy must be to assist the evolution of new applications. And that is why we have talked about communications applications. There is a role there for the Federal Government to play that that policy should recognize, but there are also other applications: in the weather satellites, in the remote sensing area, in the materials area, in defense as an application. Science, it turns out, is an application eventually, and NASA can support all these communities. We need NASA to have that role.

Finally, NASA has the need to produce advanced technology, and we need a commitment to that role as well. Those advanced technologies on the horizon are: getting the Shuttle operational, taking advantage of it and exploring it, learning how to use it, building an upper stage that can make maximum use of our capabilities and also meet our needs to go to higher energy orbits; and an orbital terminal to do work in orbit.

And those are the kind of things NASA can do which should be encompassed by a national space policy.

Mr. HOLLENBECK. Thank you.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you.

Mr. Lowery?

Mr. LOWERY. Thank you, Mr. Chairman.

I would begin by addressing a question to Mr. Augustine and Dr. Rosen. Your testimony beginning at the bottom of page 11—this quotes two paragraphs—you state:

> The budget which proposes over $1.7 billion for production of a new transportation capability, it is disconcerting, to say the least, that less than $12 million, .07 percent, is allocated to planning the next steps. The advanced programs element is key to the future of NASA and the entire civil space program, and should be significantly strengthened.
>
> The foremost need now, one which you addressed immediately, is for an advanced upper stage for the Shuttle to carry payloads unsuited for the planned inertial upper stage and payload assist modules. That a need exists for such a vehicle is attested to by the recent interest in reconfiguring the Centaur for Shuttle use. Unless we begin immediately with the definition and development of an advanced high energy upper stage, our Nation's ability to place needed payloads in energetic trajectories will be constrained. It must be remembered that the IUS was initially designed as an interim vehicle, to be used until a higher energy stage could be afforded. The need was never in doubt. With the Shuttle about to undergo its transition to operational status, we should now proceed aggressively with an appropriate orbital transfer vehicle.

I guess my question for both of you is, and for Mr. Simpson and Dr. Chartrand as well, is what do we do? I mean, we have needs, and I think beginning in the latter half of this decade, could you amplify upon that need. And I guess a more specific question is: Are we going to be flying our payloads, particularly communications satellites, on Ariáne.

Mr. ROSEN. Let me address those latter questions first. The communications community, I think, will build payloads suitable to whatever launch vehicle is available. In other words, if there is a large vehicle available they will take advantage of that. If that vehicle is not available, although they will be constrained, they will fly on what is available. Some of those, then, will fly on Ariáne, mostly not because of performance but for economic reasons unless we become very competitive. Although the IUS will be a very capable stage, we can become even more competitive by relaxing the payload constraints, that is mass to orbit, than the IUS allows, and the advanced stage will allow us to do that. So the way to maintain competitiveness is to have the IUS and an advanced stage for users to draw upon and to design spacecraft around, but at a reasonable price.

Now, I gathered in your comments, sir, that the question was how do we get a capability in that short period of time, between

now and the end of the 1990's. Was that one of the things you were addressing?

Mr. LOWERY. Yes.

Mr. ROSEN. I think we can do that.

There is no question about the payloads. The requirement for large payloads won't be there before the launch vehicle is. Until the developers really see that they have a launch vehicle they can count on they are going to be at least pushing the existing margins. But advanced payload concepts are already in hand, and we already know how to take advantage of increased throw weight to geosynchronous orbit, for example. If we had the capability we could make use of that capability very effectively, as noted in the recent joint Air Force/NASA upper stage report to Congress.

The only conclusion, then, is we should do it as expeditiously and economically as possible, and that means starting now with a reasonable program to develop a high energy upper stage.

Mr. LOWERY. You see sufficient resources available in the budget, do you?

Mr. ROSEN. In 1983, no, sir. But I think in the out years we are going to have to look at what was once a Shuttle development program and what now is going to be the advanced program, and that is why we talked about the upper stage in terms of the advanced programs that will follow the Shuttle as a major element in the national space budget. And there has always been one large program that stands out from the rest; the Shuttle or Apollo or whatever. Now, I am not suggesting that the upper stage is going to be that big, it is not. But it is going to have to fit into that category of things to get developed after the Shuttle development is complete.

Mr. LOWERY. You stressed it in your formal testimony as the "foremost need". Is that an accurate description from your perspective?

Mr. ROSEN. Yes, sir, at this time it is.

Mr. LOWERY. Mr. Augustine?

Mr. AUGUSTINE. I would basically echo Dr. Rosen's comments. The tradeoff we face is one of a near-term need to spend money in order to save substantial funds in the long term, and that is a tough tradeoff always. Certainly I think it would be fair to say we all believe the No. 1 priority is to get the Nation's economy on a strong footing. Once we have done that, then rather substantial amounts of money may become available for the kind of activities we are discussing here. That's clearly where the leverage is. At the same time we would hope we could get started on some of these activities that do have longer term payoffs.

Mr. LOWERY. Dr. Chartrand?

Dr. CHARTRAND. Well, in the long run I think we all agree here that some of that leverage for getting the economy back on track can be had out of space technology. As far as communications satellites are concerned, one thing that should be kept in mind is that the companies who are selling communication satellite services are selling just that, they are not selling satellites, and they would be just as happy in many cases if they didn't have to buy a satellite or make a big deposit, not have control of it themselves. They are selling the service and they will buy the satellite, they will buy the service, whatever is most economical for them. If it turns out to be

Panasonic and the Japanese launch vehicle, it is very likely they might be able to do that.

I think that the high-energy upper stage, whatever kind of upper stage we come up with, is one of those evolutionary goals that will grow out of the expanded presence in space, and it will be necessary both for communications satellites and any other activities we anticipate doing up there.

Mr. SIMPSON. There is a definite need for an upper stage with a greater capability than the IUS. The concern expressed in Congress last year was whether the wide-tank Centaur was the proper upper stage or whether we ought to develop a reusable orbital transfer vehicle, and that question still has not been resolved. I think that perhaps you could also develop the Centaur as a reusable orbital transfer vehicle and that should be looked into. At the present time, whatever upper stage is selected, it will not be a problem from the viewpoint of the Galileo mission requiring the Centaur as an upper stage. It is not going to be just a one-mission vehicle.

Mr. LOWERY. It will probably be missions through the private sector; it is here in your testimony?

Mr. SIMPSON. Certainly with time the communications satellites would become more sophisticated and larger, and they will use whatever boost capability is available.

Mr. LOWERY. Thank you very much. Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Simpson, I wanted to clarify something. We had a separate hearing last year, I think, on the 30/20 gigahertz satellite demonstration. I understood at that time that one of the prime reasons for interest in NASA doing the 30/20 demonstration was that it was a leapfrog of the technology that was available, and did I understand in your testimony today that the Japanese are doing a 30/20 gigahertz demonstration?

Mr. SIMPSON. I didn't state it quite that specifically, but yes, they are doing it.

Mr. FLIPPO. They are doing it?

Mr. SIMPSON. They have a satellite in orbit right now.

Mr. FLIPPO. So it would not be leapfrogging like the——

Mr. SIMPSON. It is an evolutionary growth. It is needed as the other frequency bands fill up. Communications satellite manufacturers start out using C band, 4 and 6 gigahertz, then they developed the Ku band which is 12 and 14 gigahertz, and now they want to use the Ka band, 20 and 30 gigahertz, in the 1990's.

Mr. FLIPPO. If the Japanese are doing it is it a little late for NASA to be doing a demonstration?

Mr. SIMPSON. No. That's why you can't delay it. Because the Japanese satellite is, as I understand it, not as sophisticated as what NASA's planning, but we can't afford to wait. We need a demonstration program with results by 1990 so that the commercial industry can use those results to start building operational 30/20 gigahertz satellites in the early 1990's.

Mr. FLIPPO. Let me come to Mr. Augustine for just a moment. It is not clear whether you advocate that NASA plan and demonstrate and fly a 30/20 satellite or merely the development of key technologies. Could you clarify your position on that, and what key technologies does NASA need to focus on?

Mr. AUGUSTINE. We really meant the former. We had in mind, obviously, a step-phased program. In terms of the key technologies I think I would like to ask Dr. Rosen to comment on that.

Mr. ROSEN. I would like to begin by saying the technologies we are talking about are significantly advanced from what has already been demonstrated on orbit. It doesn't mean the Japanese and others won't continue to develop their technologies as well, but we are advising that we get in that race because there is a lot of competition and the payoff is great. That payoff is probably going to have to be preceded, however, by a flight demonstration, and although there is probably no need in this year's budget to begin funding for that, the technology development that should be carried on in 1983 is going to have to be enhanced.

Now, the primary technologies, of course, are the transmitter, of which by the way there is some commonality with the military EHF systems; the receiver, which is at a different frequency than the military is planning to use; the signal processing and switching equipment on board; and perhaps most notably, the antenna system which is completely different than what anybody else is flying. And those are the four basic elements of the technology which need to be developed.

Mr. FLIPPO. It is certainly an interesting subject that I would love to pursue, because there are many, many questions associated with it, questions involving—I understand that the Japanese and others are really making headway in the communications industry and yet I guess our communications industry really came from Federal R. & D. efforts and private R. & D. efforts in the past, and yet as a result of that, in trying to maintain our leadership we exported an awful lot of jobs in regard to that. And I just wonder how this would tie back—it raises many very important questions—but, we must press on.

Dr. Chartrand, has the National Space Institute been involved in any surveys which attempt to project the future national needs for trained personnel?

Dr. CHARTRAND. Not specifically, Mr. Chairman. As far as the details of trained personnel, I think that the gentlemen from the AIAA and IEEE would be more appropriate to speak to that subject because they are organizations of engineers, and these are the same personnel I think you are specifically referring to. All I can tell you is that we do get many letters and telephone calls from the youth of this Nation who are interested in going into these fields, and we try to provide them with information on how to get there.

Mr. SIMPSON. The Institute seems to be somewhat divided on the need for increased numbers of electrical engineers in the future. However, there does seem to be a need for more engineers in two specific areas. The first area is the number of graduates with Ph. D.'s in electrical engineering who are U.S. citizens. Another problem is in the area of keeping engineering teachers in the colleges and universities. Eventually, the salaries of the engineering faculty are so low that teachers are migrating from universities into industry, where they can make more than $25,000 a year. And so probably there is a need for some kind of subsidy to keep them in the academic world.

Mr. FLIPPO. Well, let me direct a question to the panel, and please feel free to respond.

Do you feel that the United States is ready for the upcoming international conferences, and what issues do we need to work on?

Dr. CHARTRAND. I think that the main thing we have to be prepared for as far as the conference coming up in Vienna this summer is that all U.N. conferences, by their nature, are as political as they are technical. And the history tends to be that we are prepared technically and not particularly politically. If what I hear is correct I think both the United States and the Soviet Union would just as soon not go to the conference, but we have got to go and we and the Soviet Union will be the major presence, although with the one-nation-one-vote concept of the United Nations we will be considerably outnumbered. I think that we are going to have to spend a good deal of time preparing ourselves, technically and politically, and one of the major concerns, both for the Vienna space conference this summer, for the regional and world administrative radio conferences, is how are we going to either satisfy or defuse the concerns of the developing nations for benefits from space technology, even though they are not space-capable themselves. I don't have an answer to that yet.

Mr. FLIPPO. Dr. Rosen, do you have a response?

Mr. Augustine?

Mr. AUGUSTINE. With respect to the participation in international conferences, UNISPACE is of course high on that list. Dr. Jerry Grey, who has been the Administrator of Public Policy for the AIAA and has appeared before your committee many times, is serving as the U.N. Deputy Secretary General with responsibilities for UNISPACE. He also will be continuing in his responsibilities with the AIAA, so we will have a close coupling. In addition, the AIAA is organizing the industrial exhibit for that conference, so it will have an important role there. I would echo the earlier comment that we have been taking rather careful stock of U.S. participation in these international conferences; we find that often we send people who are capable in the fields of technology but are not well prepared to deal with the political climate at many of these conferences. We are frankly somewhat frustrated by this. We are taking some steps to be certain that our representatives in the year ahead, at least those that relate to AIAA, are extremely well prepared to deal with the problems that they will encounter.

Mr. FLIPPO. Mr. Augustine, I would like to ask you to elaborate on your comment about liquid propulsion for the record at some future time. I think that would be helpful to us.

Mr. AUGUSTINE. I would be happy to supply that.

Mr. FLIPPO. Does the panel have any further comments? Is the panel concerned about the present civilian-military split in the U.S. space program and its appropriateness?

Mr. AUGUSTINE. Well, I'd be happy to speak on that from my background as a former member of NASA's R. & T. Advisory Council and also as a former Undersecretary of the Army. I have no problem whatsoever with the current split. I think it is a very good split. I hope it can be preserved. I am not suggesting that we should build a wall with respect to technical information, and I believe by and large we have been successful in not letting such a

wall exist. I think there is a reasonable transfer of technology. It would be my view that just as research in industry has difficulty competing with profit requirements that occur every day, I think that advanced space technology will on a broad basis have difficulty competing with the need for spare parts for aircraft and so on in the Defense Department. I fear that the very important long-term payoffs of space might be neglected if they were solely within the defense arena. At the same time, many of the international benefits of our space program, I think, have been accrued principally because it was clearly civilian in nature, and I guess I would doubt that either the Defense or the NASA civilian space programs would have been anywhere near as successful as they have been had they been merged into a single program. I am not arguing against coordination or exchange of information. I am dealing principally with the matter of administration.

Mr. FLIPPO. Any other member of the panel care to comment?

Dr. CHARTRAND. I would strongly second that, and in a meeting I had with Dr. Keyworth in December I brought up the subject of the 30/20 gigahertz technology. He made a comment which I have not seen go further either in the press or anywhere else: that it might be sufficient for our national technical needs to have military, which has an interest in 30/20 technology, develop that technology rather than NASA, and have it not appear in the NASA budget. I don't know whether that occurs or that it does appear in the military budget. If it does, I think that we should express a very strong concern that such technology developed in the military does make it to the civilian end. I am just a little leery of the tendency of the military to keep as much under wraps as possible. And if we decide that in order to save money the military should develop a technology, we should make sure that what is appropriate goes to the civilian sector.

Mr. SIMPSON. It is my understanding that military communications satellites are not the same as civilian communications satellites. Their needs are different, and therefore they are not designed in the same way. While there is some overlap, there is a need for a civilian R. & D. program. You could not develop the commercial technology base, as has been suggested by some people, by just having the military R. & D. program plus private industry. NASA's participation in high-risk R. & D. is needed as well.

Mr. FLIPPO. Finally, in the very important area of space policy, we had hearings last fall on the future of the space program, and there was a consensus that indeed we need a goal, as witnesses have told us today: how do we determine what that goal should be? Do you really think that the OSTP study will do it? Mr. Augustine, I believe you said that the budget process is not a way to set goals. Now, I think we all agree with you. Things like the Space Operations Center has been suggested as a goal, but that is really a means, not a goal. How should we approach that? Is the 1958 Space Act still relevant? Gentlemen?

Dr. CHARTRAND. Well, I think—let me say just one thing, that the Soviet Union has essentially treated permanent presence in space as a goal. And thus I think it would not be totally inappropriate for us to do so as well. Therefore, a manned space station is not just a means but is also to some extent a goal in itself.

Mr. SIMPSON. I look at a manned space station as a basic capability that this country needs, and something that we should definitely have. I think we have to make a basic decision that we are going to expand our capability in space, and to use it to our advantage.

Mr. ROSEN. I would like to make a brief comment, but precede it by two plugs. Early this year our committee undertook an assessment of where we are going between now and the end of this century in the space program—a broad, technical, programmatic assessment—and it was a very interesting exercise. We did it for the National Academy of Sciences.

Mr. FLIPPO. Is that a document you might care to submit for the record?

Mr. ROSEN. Yes, sir. We would be happy to. It is being summarized so you will be able to read it more readily, but the full document is certainly available to you. And that activity gave us an idea where we might be going, some vision of the future. And recently, and here is my second plug, the committee published this book "Working in Space" which is a summary of all our manned activities and some idea of where we might go in the future. It is a good reference book for the lay person especially, because it deals in an understandable, readable way with the manned activity of the space program, and concludes that the manned operator is really essential to our future space progress. Now, with that in mind, let me answer your question briefly. My personal opinion is that although goals are nice, it is not to have goals that we have a space program. We have a space program to have an orderly development of technologies and capabilities that we need as a Nation to progress. Now, if that involves setting up a goal as something to shoot for and work for, fine, but I don't think for one we should be goal oriented. We should have a rational program aimed at the normal evolution of the capability to use space in the national interest. It turns out as we said in our testimony that the kind of advanced programs we discussed, including an orbital transfer vehicle and some kind of an orbital terminal which could evolve into a work platform or even a space station at some time in the future, is a rational program that should be pursued. It will take a long time to develop that capability. It may continue to evolve for a long time. Each milestone along that evolution may become a goal. But to me and the others I have talked to in our committee and the AIAA, that is a rational way to approach the future of our space developments.

Mr. FLIPPO. If the study that Dr. Keyworth has underway contains no new major space initiative, what will happen, do you think, to NASA and the science community and the industrial base?

Mr. AUGUSTINE. In my judgment, we will continue to spend a substantial amount of money with much less focus and 10 years from now when we look back we will discover we spent it in bits and pieces without producing any truly significant results. That is perhaps a bit of an overstatement, but certainly the thrust of the comment I think is appropriate.

Mr. FLIPPO. Dr. Rosen?

Mr. ROSEN. Well, again, just a personal opinion. I am not sure that the establishment of a program is really a necessary element

of policy. The program should be designed to implement and execute policy. The policy might be much broader than a single programmatic endorsement, and I for one wouldn't be unhappy to see that, if in fact the administration then stepped up with the programmatic commitments necessary to implement those items of policy.

Mr. FLIPPO. Dr. Chartrand?

Dr. CHARTRAND. I am afraid that if we don't set some kind of goal that you are going to see a continuation and exacerbation of the situation that exists in NASA. And you will end up with people who are goal oriented, the most active people, leaving NASA, as we have, and you will be left with an agency that contains what the public considers the worst type of bureaucrats, the people who are not particularly active. And I think that the high-technology industry or an institution like NASA really does need some kind of goal c' .llenge.

Mr. FLIPPO. Mr. Simpson?

Mr. SIMPSON. I would say that without a goal or series of goals, that you are going to see a continuing stagnation at NASA, and further decline. Certainly a space station should be initiated. But that should not be the only thing. We also should move forward in applications and space science.

Mr. FLIPPO. Thank you, gentlemen.

Mr. Nelson?

Mr. NELSON. Thank you, Mr. Chairman. I have had the delight to speed read your testimony since I missed the oral presentation, and I just want to summarize my concerns by asking if you all have any further commentary, in summary, to this question. Does the proposed 1983 budget by the President represent adequate research and development for space science and applications? And each of you have taken off on it in a different way in your particular presentations, and we have got a battle on this in the Budget Committee coming up shortly. And any punchy emphasis that you could help with would be appreciated.

Mr. ROSEN. I don't know how punchy this is going to be, sir, but——

Mr. FLIPPO. Would you care to define that word? [Laughter.]

Mr. NELSON. Stars, underlining.

Mr. ROSEN. Maybe I'd like you to define "adequate," because that is also tough to deal with. But my answer would have to be no, that there are fiscal constraints that make it impossible to do things that you want to, and we are in an age where you don't have money to do what you need to do. As we said, we understand that. That is a problem we have to deal with. In the current budget, although it is an increase, it is not necessarily, as our testimony said, cause for rejoicing. there are many things needed for the future of this country, the fairly near-term future of this country, that need to be done for which there is not sufficient support in that proposed budget. Well, by that standard of adequacy I would have to say no, and we have talked and written about what some of those things are.

Mr. AUGUSTINE. I would add that at a time of very austere budgets in most areas that overall we would view the present budget as a not unreasonable minimum. That is probably more supportive

than most of the statements you heard from our Institute in past years. I would of course hasten to add that there are some specific instances where the addition of modest amounts of money could have important long-term payoffs, and we hope those would not be neglected. I would also say that in the area of creating a space policy, we are concerned that the one the Government produces may not be to our liking and so we are in the process of producing one of our own, which we hope to have for you in early May.

Mr. NELSON. If that is your characterization of the 1983 budget, what would be your characterization of the 1982 budget?

Mr. AUGUSTINE. Very austere.

Mr. FLIPPO. Yes, sir, it is Dr. Chartrand.

Dr. CHARTRAND. Well, Mr. Nelson, I think to try and summarize briefly, the 1983 proposal is not adequate, but it probably is acceptable, given the constraints under which we labor. And I would simply urge you and the other members of the subcommittee when you are discussing with your colleagues this funding for NASA, not to underestimate the intangible aspects of our space program, both for the public spirit and mood of our citizens and the public foreign policy implications of our goals outside the Earth.

Mr. SIMPSON. I would like to draw some asterisks and stars and underlining. I would like the subcommittee to increase the NASA budget by $25 to $30 million to begin a 30/20 gigahertz flight demonstration program.

Mr. FLIPPO. Thank you. Gentlemen, I deeply appreciate your testimony. It has been very helpful and very important. We have enjoyed receiving it. We look forward to you joining us again. Thank you very much for being here.

[Whereupon, at 3:32 p.m., the hearing was adjourned.]

1983 NASA AUTHORIZATION

WEDNESDAY, FEBRUARY 24, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to adjournment, at 10:07 a.m., in room 2318, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Mr. FLIPPO. The subcommittee will come to order.

Today the Subcommittee on Space Science and Applications continues authorization hearings on the NASA fiscal year 1983 budget request. Our witnesses include representatives of the Air Force; the European Space Agency; and the Aerospace Safety Advisory Panel.

Our first witness today is the Honorable Edward C. Aldridge, Jr., Under Secretary of the Air Force, accompanied by Brig. Gen. Bernard Randolph, Deputy Chief of Staff for Research and Development and Acquisition, who will discuss Department of Defense participation in the Space Transportation System.

In anticipation of more discussion related to the IUS/Centaur decision, we have asked Gen. James Abrahamson, NASA Associate Administrator for the Office of Space Transportation Systems, to join us for response to questions.

We are, indeed, pleased to have you and look forward to your testimony and I would like to recognize the ranking minority member of this subcommittee, Mr. Hollenbeck, the gentleman from New Jersey.

STATEMENT OF HON. HAROLD C. HOLLENBECK, U.S. REPRESENTATIVE FROM NEW JERSEY

Mr. HOLLENBECK. Thank you, Mr. Chairman. I, too, would join in welcoming our witnesses today.

Mr. Chairman, on page 50 of the February 22 issue of Aviation Week and Space Technology, there is an ad by Ariane-space, the first commercial space carrier.

Many witnesses who have testified before us in the last 2 weeks have expressed concern over NASA's ability to compete with this commercial launch system. I, also, share this concern, as do many of us, in the light of NASA's austere fiscal year 1983 budget request.

Page 51 of Aviation Week lists the customers for Ariane. Over 13 organizations are listed. My concern is that three United States companies are included in that list.

What makes this expendable launch vehicle so attractive to cause United States companies like Western Union, Southern Pacific Communications, and General Telephone & Electronics to seek its use? Is the Space Transportation System too expensive for commercial users, or have the French developed a truly exceptional launch system?

One of the key elements for the Space Shuttle to effectively compete in this new marketplace is the STS upper stage. The decision to cancel the Centaur leaves us with a limited ability to launch only a 5,000-pound payload from low earth to geosynchronous orbit. The next generation Ariane vehicle will soon be able to match, and by the late part of this decade, surpass this capability.

The decision in choosing IUS over Centaur was near-term economics. However, I would hope that we would make our choice of an upper-stage vehicle not on the grounds of short-term considerations only. We must view this decision in the context of enhancing our Nation's space transportation system.

I do not want to find out a few years from now that we authorized the degradation of the Space Shuttle because we unwittingly authorized an upper stage with a dubious cost history and questionable performance. I would like to be assured that our efforts are aimed at maximizing Shuttle performance.

I look forward to the insight of our distinguished witnesses as we continue these hearings, Mr. Chairman.

Mr. FLIPPO. Thank you, Mr. Hollenbeck. Do other members of the committee have opening statements? If not, gentlemen, we will be pleased to have your testimony. We will be pleased to include the full testimony in the record. Please feel free to summarize as you deem appropriate.

STATEMENT OF HON. EDWARD C. ALDRIDGE, JR., UNDER SECRETARY OF THE AIR FORCE, ACCOMPANIED BY BRIG. GEN. BERNARD RANDOLPH, DEPUTY CHIEF OF STAFF FOR RESEARCH AND DEVELOPMENT AND ACQUISITION; DR. CHARLES COOK, ASSISTANT UNDER SECRETARY OF THE AIR FORCE, SPACE POLICY AND PLANS; GEN. JAMES ABRAHAMSON, NASA ASSOCIATE ADMINISTRATOR FOR THE OFFICE OF SPACE TRANSPORTATION SYSTEMS; AND L. MICHAEL WEEKS, DEPUTY ASSOCIATE ADMINISTRATOR OF SPACE TRANSPORTATION, NASA

Mr. ALDRIDGE. Thank you, Mr. Chairman, for giving me the opportunity to speak before this committee to discuss the Air Force activities and issues associated with the United States Space Shuttle.

As you mentioned, with me today is Dr. Charles Cook, who is a Deputy Assistant Secretary of the Air Force for Space Plans and Policy and General Bernard Randolph, Director of Space Systems and commanding Control and Communications in the headquarters, U.S. Air Force.

I have a prepared statement which I would like to insert for the record but I would like to summarize that as appropriate this morning.

In your letter to the Air Force on February 2, you asked for the status of the Shuttle development, Shuttle production, and transi-

tion to an operational capability. You indicated a particular interest in the Air Force Shuttle-related facilities, operations at Vandenberg Air Force Base, Inertial Upper Stage development, Air Force requirements for a higher energy upper state, the Air Force position on the Orbiter fleet size and the requirements for Shuttle thrust augmentation.

I would like to briefly summarize the status on each of those issues and my prepared statement obviously addresses them in more detail.

Let me first assure you that the Department of Defense and the Air Force are fully committed to the utilization of the Shuttle capability.

By mutual agreement in 1977, the Air Force is to provide and operate the Vandenberg Air Force Base facility to develop the Inertial Upper Stage for national users and to integrate DOD payloads on the Shuttle. NASA is to develop and procure the Shuttle and operate the Kennedy facility.

We are delighted and encouraged with the success of the first two Shuttle flights and anticipate continued success on the third flight to be launched on March 22, and the fourth flight which is to carry the first DOD payload, among other payloads on the Shuttle.

The success of the Shuttle, so far, has led us to support the following Air Force program plan:

A first dedicated payload launch in October 1983, from the Eastern Test Range at Kennedy facility;

The first IUS launch, late this year;

The first Shuttle launch from Vandenberg Air Force Base on the West Coast in October 1985;

The initial operation of the Air Force Consolidated Space Operation Center, known as the CSOC, for Shuttle operation in late 1987; and

The development of a Shuttle integrated high energy upper stage for utilization in the late 1980's.

With regard to the Shuttle fleet, we are satisfied that the current Shuttle production rate and delivery schedules can meet the DOD payload launch schedules. However, unanticipated delays in delivery, problems in turnaround after flight, or possibly Orbiter attrition through some failure, could force the Department of Defense and the Air Force to exercise its priority over noncritical Shuttle missions; those which are not dealing with national security matters.

It is for these reasons that we believe it is prudent to continue with additional Orbiter procurement to insure the viability to Shuttle program for all users.

The only other option that we might have is to continue with additional expendable launch vehicles after the Shuttle becomes operational to reduce the schedule demands on the limited Orbiter fleet.

This fleet strategy is one subject of a study under the direction of Dr. J. Keyworth, President, Scientific Advisor, on a national space policy. We expect that study to be finished some time this year.

On thrust augmentation, the Air Force requires the Shuttle of the thrust augmentation provided by the filament-wound cases on the solid rocket boosters. This performance augmentation is man-

datory to regain the capabilities which we used to specify the first Vandenberg launch mission in October of 1985.

I wish to emphasize that the filament-wound case thrust augmentation only regains the originally advertised capability of the Shuttle on which we based our mission capability. It also has the additional benefit of increasing the life of the main engines on the Shuttle since they will be able to operate at reduced thrust levels.

On Vandenberg, the Shuttle launch pad construction at Vandenberg is currently on schedule.

Last year it was realized that problems in hiring qualified personnel at Vandenberg and the accommodating change orders resulting from the first Shuttle flights, would make it impossible to meet the planned Vandenberg Air Force Base availability date of August 1984. October of 1985 was selected as an achievable launch availability date. Since that time we have had to add an environmental shelter to protect the Shuttle and to achieve other secondary benefits.

On the Inertial Upper Stage, the IUS program is one in which the Air Force is not quoted as an example of success. The cost has increased substantially and we have had significant schedule extensions. The problems have been: (1) Too much optimism in our ability to develop a Solid Rocket Stage; (2) changes as a result of parallel efforts with the Shuttle development; (3) change in orientation of the program from an initial upper stage to a longer-term effort; and (4) NASA pulling out of the three-stage IUS, thus increasing the Air Force share of the production costs. However, the performance estimates meet or exceed our expectations and our requirements.

We have recently completed an informal study to investigate options to proceed with IUS production and have decided that as a result of the current status of the IUS program the cost and risk to proceed with another upper stage to replace the IUS at this time was prohibitive.

While the IUS can satisfy all current projected requirements, it is clear that additional upper stage performance will be required in the late 1980's as we strive for more survivability, for space systems and enhanced surveillance and communication capabilities.

We would anticipate the requirement to replace as much as 10,000 pounds or more at geosynchronous altitudes.

A recent study for assessing the options for IUS made us recognize more strongly than before that we, indeed, needed to get started on a high energy upper stage and a more rapid pace than was provided in the fiscal years 1982 and 1983 programs. Therefore, we have initiated a reprograming effort in fiscal year 1982 to provide $4 million to start a joint DOD/NASA study which could lead to the competitive development of high energy upper stage in the late 1980's.

In conclusion, let me say that the Air Force is committed to expanding its capabilities in space. It makes good military and good economic sense. To do this we will need confident access to space through a reliable and responsive launch system. We will need the means to protect our space assets from those who would attempt to deny us the use of space. We will need a vigorous technology program to provide U.S. future options for the military use of space.

We will need an effective management structure to better coordinate our space system's acquisition and operations, and we will need the continued support of the Congress to achieve our national security objectives.

Thank you, Mr. Chairman. Dr. Cook, General Randolph, and I are available to answer any questions that you may have.

Mr. FLIPPO. Thank you, Mr. Secretary. Mr. Hollenbeck, would you have any questions?

Mr. HOLLENBECK. Thank you, Mr. Chairman. At this time I would yield to the gentleman from Florida, Mr. Nelson.

Mr. NELSON. Thank you, Mr. Hollenbeck. Thank you, Mr. Chairman.

I want to talk a little bit about the IUS. It started out being called the initial upper stage, and then became the interim upper stage or the initial?

Mr. ALDRIDGE. I think it was interim upper stage rather than initial.

Mr. NELSON. And now is it called the inevitable upper stage? [Laughter]

What I want to pick up is Mr. Hollenbeck's and my questioning of one of the NASA witnesses the other day.

First of all, can you tell me, Mr. Secretary, what was the primary reason for the Air Force decision to go ahead with IUS over another upper stage like Centaur?

Mr. ALDRIDGE. At the original time or in the recent timeframe?

Mr. NELSON. Recently.

Mr. ALDRIDGE. There was a study performed last fall. I believe it was submitted to the Congress in November of 1981 looking at the requirements for payload to be delivered to various orbits. That was a joint Air Force, NASA, DOD study. Dr. Cook participated in that particular study.

At that time, the requirements to launch particular payload weights to various altitudes as far into the future as was foreseeable at that time. The IUS was capable of performing that function. The reason it was capable of performing those functions was that our payloads were, in fact, designed to fit on top of the IUS for the foreseeable future.

Part of that study also dealt with NASA requirements to perform the Galileo and the Solar Polar missions and I can ask the NASA people on the specifics of that. But, at that time, the long tank Centaur program was sufficient to perform their missions for that role.

At that time, as a result of the fact that the IUS would, in fact, meet our requirements for the foreseeable future we decided that that was the program to proceed on at that stage.

Mr. NELSON. What about 85? You are saying that you have a schedule risk for 1985, a classified mission that can only be met by the IUS? Is that correct?

Mr. ALDRIDGE. No, sir. There are missions ahead of the 1985 period. All the requirements—the Department of Defense requirements—for payload delivery to the various orbit altitudes that we can foresee at this time, can be met by the IUS.

Mr. NELSON. Well, IUS has never been tested. What happens if you have a problem? Let us say, hypothetically, that you have a problem, what kind of backup is going to be available for IUS?

Mr. ALDRIDGE. Right now there is no backup for IUS, sir. There have been about 14 engine firings that have been successful. The performance estimates that come from the Air Force and the contractors indicate in their ground testing which has occurred that their performance specifications are such that they will meet the requirements.

Mr. NELSON. Well, you say there are no backups. Has not the Air Force provided a Titan backup?

Mr. ALDRIDGE. That is for a different mission, sir. The IUS will deliver payloads to geosynchronous altitudes and that is on the Shuttle program. The IUS also is being integrated in the Titan boosters for a specific mission. As far as the missions regarding launch—as a matter of fact the first DOD mission in 1983 is a Shuttle IUS launch.

Mr. NELSON. If, in that timeframe of 1985, the IUS was not capable of flying on those classified missions, you are saying that there is no backup? You could not do it with a Titan?

Mr. ALDRIDGE. Sir, there are many of them that—no, sir. I believe that there are some missions that you could, in fact, perform with a backup but many missions you could not.

Mr. NELSON. Look at the timeframe of 1987. Is the IUS going to be able to put up the size payloads that you need in 1987?

Mr. ALDRIDGE. Yes, sir. As far as we can predict the requirements right now for 1987, IUS will meet the performance requirements.

Mr. NELSON. That is because you are thinking that the present capability of IUS of 5,000 pounds is expected to be stretched to a capability of about——

Mr. ALDRIDGE. No, sir. We are designing our payloads to fit on top of IUS so, by definition, they will meet the requirements.

Mr. NELSON. Of 5,000 pounds?

Mr. ALDRIDGE. Yes, sir.

Mr. NELSON. That is interesting. When do you see the need then for greater than a 5,000 pound payload at that time, and what time is it that it can be met by an IUS?

Mr. ALDRIDGE. I would predict that toward the end of 1987, early 1988 we will begin feeling the pressures from the various users of space to expand the capabilities by improving the survivability and endurance of our space assets and putting additional payload packages on board. So the weight requirements for those particular payloads will grow beyond the 5,000 pounds that we use as the definition for IUS and that will be in the late 1980's.

Mr. NELSON. That is moving into what you call the high energy upper stage?

Mr. ALDRIDGE. Yes, sir.

Mr. NELSON. And that should be ready in the late 1980's?

Mr. ALDRIDGE. What I suggested and what we are asking for the Congress to permit the Air Force to do is provide $4 million in fiscal year 1982 to begin the studies—the joint NASA/DOD studies—that would lead us to a high energy upper stage capability in the late 1980's and that means the 1987 to 1988 timeframe.

Mr. NELSON. Could the Centaur, riding on the Shuttle, meet the mission requirements?

Mr. ALDRIDGE. Yes, sir.

Mr. NELSON. All right. What is the contemplated development cost for the high energy upper stage?

Mr. ALDRIDGE. That has not been defined at this point because we have no specific definition of what that high energy upper stage will look like or be. The plan would be to use a competitive development program where we would use the expertise that exists in several of the contractor facilities of which we would expect Centaur or a Centaur derivative would certainly be one of those competitive programs.

Mr. NELSON. You mentioned earlier in your testimony the $4 million for fiscal year 1982. Are you saying that you have not projected this out in the development of the new high energy upper stage over the next several years?

Mr. ALDRIDGE. Not at this point. The studies that were done just recently, looking at the IUS versus the Centaur and other options for IUS, really brought into focus the fact that we need to get on at a much more rapid pace with a high energy upper stage than we had previously planned. It is clearly brought out from our study activities.

As a result, we had no funds in fiscal year 1982 to do that nor in fiscal year 1983, as a matter of fact. We were thinking of putting the funds in fiscal year 1984 as part of our current deliberations on the budget. We clearly indicated, as a result of that study, that we needed to move on at a much more rapid pace with that and, therefore, that is the reason we have requested the reprogramming action in 1982.

The definition of what that stage may look like—whether we will use to a great extent existing technologies and existing engines or other components is yet to be defined and that is the purpose for spending the $4 million to see if we can define a program that we can include in our budget. I would like to make sure that it is clear that this would be a joint effort between ourselves, the Air Force and NASA, to define the requirements and define what a program would be to carry out those requirements.

Mr. NELSON. Mr. Secretary, I have dealt with the Air Force quite a bit with regard to budget projections and I know that you project in the future of what items are going to cost. Is it not true that over the period of time through 1988, that you project that the development of the IUS and the new high energy upper stage is going to be over $1 billion. Is that not true?

Mr. ALDRIDGE. I think that that is the combination of those two. Around $1 billion is probably correct. I would have to go back and check the accuracy of the number but I think that is probably right.

Mr. NELSON. Why did you say then that you had no budget projections?

Mr. ALDRIDGE. We have no budget projections for the high energy upper stage, per se. We do not have a program laid out for that.

Mr. NELSON. If it is over $1 billion, you have a projection of what, by fulfilling the same mission with the Centaur, what that would cost over the same period of time through 1988?

Mr. ALDRIDGE. The IUS meets all of the performance requirements for all of our payloads through the 1977 period.

Mr. FLIPPO. Would the gentleman from Florida yield and perhaps we could ask Mr. Secretary and General Randolph to provide the subcommittee with a comparison of the IUS and Centaur costs, including development costs, any Orbiter modifications and production buys for an equal number of vehicles for the record. Perhaps that would clarify and satisfy the interest of the gentleman from Florida.

Mr. ALDRIDGE. Yes, sir.

[The information follows:]

IUS AND CENTAUR COST COMPARISONS

One problem we face in discussing this subject is that the costs are never put on a comparable basis. The following table will do that by comparing the content of the IUS full scale development (FSD) with a similar grouping of costs for the Centaur development.

UPPER STAGE DEVELOPMENT

[In millions of dollars]

	IUS FSD (AF data)	Equivalent Centaur cost (NASA data)
IUS FSD work content:		
R. & D. on stage and support equipment		230
Build 9 vehicles	700	270
Launch 2 vehicles		16
Modify 2 orbiters	0	110
Subtotal [1]	700	626
Additional development costs (AF data):		
DOD requirements [2]	0	175–320
Subtotal	700	801–946
DOD payload modifications and transition costs [3]	10–20	200–500
Total	710–720	1,001–1,446
Work content:		
Hardware (8 vehicle buy)	44	30
Launch services	12	8
Subtotal [4]	56	38
Potential additional costs (AF data):		
Redundant avionics	0	+16
Other DOD requirements	0	Unknown
Total [5]	56	54+

[1] Even comparable data shown has several limitations. It does not consider increased Centaur lift capability (10,000 lbs. vs 5,000 lbs.) relative to IUS; IUS costs would be higher if escalated to same timeframe as Centaur development.

[2] AF estimate of additional work required to meet DOD requirements is from Oct. 1981 NASA/DOD Report to the Congress titled, "Upper Stage Alternatives for the Shuttle Era." The report data was in fiscal year 1981 dollars, so it has been escalated to approximately the same timeframe as the NASA costs shown above. The DOD requirements include: Greater orbital injection accuracy; redundant avionics; spacecraft load alleviation; orbiter bay loiter capability; adequate payload length provisions; and other payload/stage electrical and mechanical interface provisions. Range of costs is determined primarily by whether redundant avionics are included. Estimates are based on IUS experience; precise costs would depend on how requirements are actually implemented in the Centaur program.

[3] Preliminary AF estimate of spacecraft modifications plus first time integration for all DOD payloads to transition from IUS to Centaur. IUS costs represent minor modifications to IUS (not spacecraft) to grow IUS to about 5,400 pounds to provide for limited near term spacecraft mission growth and eliminate need for spacecraft weight reduction efforts.

[4] IUS costs based upon 8 vehicle block buy beginning in fiscal year 1983.

[5] Only cost of redundant avionics can be estimated now; other costs depend upon precise technical approach used in Centaur vehicle to satisfy the requirements. Totals also exclude integration and institutional costs and payload unique costs.

Mr. NELSON. I will include, Mr. Chairman, with this, information that I have which is that you are looking in the range of development of Centaur of about $600 million over that same period as compared to a development cost of over $1 billion on Interim Upper Stage. So, the question that logically leaps to our lips at that point is that if you have stated that Centaur can perform the same mission, is it not in the best financial interests of the United States that we go with the Centaur which will in fact cost us a lot less.

Mr. ALDRIDGE. Can I clarify those numbers?

Mr. NELSON. I surely wish you would.

Mr. ALDRIDGE. About $600 million worth of those numbers have been sunk into the IUS program. So, much of the full-scale engineering development for IUS is already behind us. We have a full scale engineering development program for nine vehicles and that is about $600 million—I think the number is closer to $595 million, but approximately $600 million is behind us.

Mr. NELSON. $600 million of the over-the-billion cost that you are talking about?

Mr. ALDRIDGE. I do not know where the billion dollar figure came from but let me explain what the numbers are. That is sunk cost and now the question comes up for nine vehicles which we have a fixed-price contract with the Boeing Company to deliver nine vehicles under a full scale engineering contract.

The question is should we continue that production for additional vehicles for the future—beyond the nine which are already under contract. The study which you are quoting is a study that we just recently performed to look at the option of rather than buying the production of IUS beyond the nine, to go with another upper stage that might be common with NASA and the Department of Defense and, particularly, the Air Force.

We looked at that issue. We would have to add now—start the Centaur development program—and the numbers run on the order of $230 million for the additional cost of the Centaur development. OK. That does not buy us a single new vehicle. Then we have to start to go ahead and start the procurement of those particular vehicles. If we did that and proceeded along that path we would have to make some adjustments on our schedule to accommodate the Centaur because we would no longer have IUS. Those costs now do not include the additional trans stages we would have to buy in the Air Force to begin filling the gap, nor the additional Titan boosters to fill the gap because we no longer have an IUS that can fly on a particular payload.

In addition to that, it does not include the cost to modify the Shuttle to be able to accommodate the Centaur program. When you begin to add all those other costs plus the very uncertain costs, which are not in those numbers—of what is the Mod cost to the DOD payloads necessary to make it fit on to a Centaur, that we have already designed to fit on the front of the IUS, we would have to change them and we do not know the cost of that particular modification. The costs are likely to be very high because many of those payloads are very sensitive.

When you add all of those numbers up, we found that the cost differential was such that either way one could go would probably be a wash with the exception of the risk associated with scheduling

and costs to the DOD because we would have to accept that design without, again, any backup, was unacceptable to us. Therefore, we proceeded with a program in being and which we have designed and planned to launch before the end of this year, the IUS.

Mr. NELSON. Mr. Secretary, one of the primary functions of our role in the Congress is to control the purse strings and to allocate those moneys in the most efficient, effective way to produce and be able to run the mission. In the supplying, as the Chairman has asked you to do, of these figures, we would encourage what you have just said. We want you to supply the figures in the overall, not just focused in on NASA, not just focused in on Air Force, but the overall picture. I think there will be discovered along here that where you are talking about the $600 million that has already been expended for the IUS, if you separate that out and talk about the high energy upper stage, that we might well see some development costs approaching in excess of $1 billion. This is what I want us to examine as we try to determine whether that is financially the best decision, considering all the other things that you mention.

Mr. ALDRIDGE. Yes, sir. I understand your question.

Mr. FLIPPO. The time of the gentleman has expired. Does the gentleman from California have any interest in this matter?

Mr. LOWERY. I have a couple of questions, Mr. Chairman.

Mr. FLIPPO. The gentleman is recognized.

Mr. LOWERY. Mr. Chairman, I might add to the cost comparisons that you asked for. I would like to see those projected into the mid-1990's. I understand the short-term budgetary problems for fiscal year 1983 but I think folks in the Air Force and NASA are getting the messages coming through from the questions from Mr. Holenbeck and Mr. Nelson, as well as questions I myself have asked on a number of occasions, that we are really concerned about the costs.

I have some real concerns with another study underway for some needs that seem to have surfaced in a memo yesterday over on the Senate side and possibly a joint use factor, makes some sense. I just have some trouble with some of the conclusions.

Let me get into a few questions for the record if I might, Mr. Secretary.

Would you state for the record what IUS originally anticipated costs were and what the costs are today?

Mr. ALDRIDGE. Let me give you approximate numbers. I can provide specific numbers for the record.

I believe, back when the program was started, they estimated about $250 million for the development costs of the interim upper stage. That number today, for the full-scale engineering and development is approximately $1,100 million. That is for the full-scale engineering development plus nine vehicles—flight vehicles.

[The information follows:]

ORIGINAL VERSUS CURRENT IUS COSTS

The cost of the IUS full scale development contract (including development and production of 9 vehicles) was $314M. It is now estimated at $700M (contract ceiling).

Mr. LOWERY. Are those nine vehicles included in each of those prices you are giving?

Mr. ALDRIDGE. The user price, the launch service——

Mr. LOWERY. Are the nine vehicles being included in the $250 million projected and $700 million actual or is that over and above?

Mr. ALDRIDGE. Just a second. My experts tell me that the $250 million was just the development costs and did not include any vehicles. The $700 million is the development costs plus the nine vehicles.

Mr. LOWERY. OK. On page 10 of your testimony you discuss a reprograming request to cover, "additional IUS cost growth." When do you plan to submit this request and what is the approximate increase of costs in IUS production in this request and before which congressional committees will you be presenting the request?

Mr. ALDRIDGE. I think General Randolph, who has the action on that can probably answer the question better than I can.

General RANDOLPH. We plan to present the request for the reprograming to the House and Senate Armed Services Committees and the Appropriations Subcommittees are associated with that.

Mr. LOWERY. How much are we talking about?

General RANDOLPH. We are talking $4 million in fiscal year 1982 for the reprograming.

Mr. LOWERY. This is reprograming for IUS cost growth?

General RANDOLPH. I am sorry. The reprograming for the IUS cost growth is $67 million and we plan to present that to the same committees.

Mr. LOWERY. That is over and above the $7 million?

General RANDOLPH. That is included in the $700 million.

Mr. LOWERY. If your production by five IUS vehicles is approved, when will you supply the IUS vehicles—that is over and above the nine?

General RANDOLPH. Yes, sir.

Mr. LOWERY. And what do you anticipate the additional five will cost?

Mr. ALDRIDGE. Those additional five are the ones that we talked about the production—the first production run—after the nine vehicles. The estimated cost of those—are you talking about the hardware cost or the total cost?

Mr. LOWERY. Hardware costs.

Mr. ALDRIDGE. The cost of the contract——

General RANDOLPH. Let me correct one thing. The $67 million reprograming is for this buy that you are talking about—the follow-on buy of the five vehicles. We anticipate that these five vehicles will run approximately $55 million each.

Mr. LOWERY. And for what time period—when do you expect them to be exhausted?

General RANDOLPH. 1985—we will expect those vehicles to last up to 1985.

Mr. LOWERY. And to be used up?

General RANDOLPH. During 1985.

Mr. LOWERY. During fiscal year 1985, The nine are used prior to 1985?

General RANDOLPH. The nine plus the five would take us with a capability into 1985.

Mr. LOWERY. And you would hope that a high energy upper stage would be available by 1987?

Mr. ALDRIDGE. Yes, sir. 1987 or 1988.

Mr. LOWERY. What are the estimated costs between 1985 and 1987, 1988?

Mr. ALDRIDGE. The plan would be——

Mr. LOWERY. And if you accelerated a high energy program in conjunction with NASA, would there not be a cost savings? Have you looked at that?

Mr. ALDRIDGE. When the study was done to look at the options for the IUS and Centaur we tried, with cost consciousness in our minds, to make sure that the program would fit within our fiscal constraints. Therefore, the assumption was made that we would need the funds from the IUS production to begin to offset the increased costs of adding a Centaur development program to our budget.

The assumptions were that, as a result of that, we would have to accept such a high risk that that was not a prudent course. If, for some reason, the Congress would add the funds to produce the additional five vehicles for IUS, coupled with the development for Centaur then we could, in fact, provide for the Centaur in the 1986 timeframe that would be a follow-on to the five IUS procurements. But, that would require both the production of IUS while we are also developing the Centaur.

Mr. LOWERY. So, in essence, Mr. Secretary, you made the decision to have these programs follow on as opposed to——

Mr. ALDRIDGE. Yes, sir. Because of the funding constraints in the near term.

Mr. LOWERY. Without looking at what the ultimate savings might be had we a concurrent development?

Mr. ALDRIDGE. Well, sir, one part of that, as I mentioned before, as far as requirements go, the IUS met the DOD requirements through the 1987 timeframe. So, what we are looking for is if there could be some joint savings as a result of combining—a joint program.

In the near term, unless we are going to add both of those programs up, we saw no distinct savings over the near term and our DOD requirements were satisfied with the IUS.

Mr. LOWERY. Let me ask more specifically. If you engage in a joint study with NASA for a new high energy upper stage and proceed with the competition and then develop and produce the new vehicle, all the while continuing funding for IUS, what are your anticipated costs for upper stages compared to your costs for developing the Centaur now?

Mr. ALDRIDGE. Over the long-term, as I mentioned before, we have no specific total cost development because we have not defined a program. But, I would anticipate the cost of that development plus the procurement of stages to carry us out, would be in the order of $1 billion.

Mr. LOWERY. Mr. Chairman, if I could ask a final question. It just strikes me that the marriage between the Air Force and NASA is critical and it strikes me from the numbers that we have looked at, that there will be some savings. I am anxious to get your followup report comparing them. Have you identified—it seems that you have from your memo—a definite DOD requirement for a Centaur-type upper stage that will coast 10,000 pounds to geosynchronous orbit in the 1987-1988 timeframe? If you used a Centaur vehicle,

NASA could perform the Galileo mission quicker with greater scientific returns. Jim Beggs testified, as well as General Abrahamson in terms of a reduction in mission goals of Galileo without a Centaur-type upper stage.

Without a Centaur-type upper stage it strikes me that the United States is going to be somewhat ill equipped to compete with the Europeans and the Japanese for the commercial satellite business. In fact, I see an article here from Aviation Week with Ariane advertised now and I am not sure how that has been factored in. I also have letters from Intelsat and Comsat in terms of their needs for later on in this decade. I have some concerns with DOD, with NASA, with our commercial needs. I have also some real concerns for the taxpayers across the Nation—the continuation of what we know is going to be an inadequate upper stage, about 5 years out—and why necessarily another study is needed when we are staring those kinds of facts in the face.

Mr. ALDRIDGE. The problem that we saw, from the Department of Defense standpoint, of proceeding now with a high energy upper stage Centaur was the fact that the schedule was driven by the 1985 Galileo launch.

Mr. LOWERY. Well, if that were slipped 6, 7, 8 months?

Mr. ALDRIDGE. In my discussions with Mr. Beggs at NASA, if NASA could foresee the need or foresee the rationale for slipping the Galileo mission by a year—6 months we did not address, but a year——

Mr. FLIPPO. Would the Secretary please state whether or not that was for the long or the short Centaur?

Mr. ALDRIDGE. It was for the joint, what we call the short-tank Centaur, which could meet both NASA and DOD missions. The Department of Defense requires a shorter tank because of the length of our payload. We could proceed with a short-tank Centaur or a 1986 timeframe as opposed to a 1985 timeframe. Much of the risk that we felt was unacceptable would go away.

Mr. LOWERY. And you are looking at what in 1986? Was that April as opposed to September 1985?

Mr. ALDRIDGE. Yes, late 1986.

Mr. LOWERY. Late 1986. OK.

Mr. NELSON. Would the gentleman yield for a question on that?

Mr. LOWERY. Yes.

Mr. NELSON. Well, that would still get the mission there. If you launched it a year late in 1986, you would still get it there in 1988 as opposed to the 1989 timeframe. Would it not?

Mr. ALDRIDGE. You would have to ask the NASA representatives about the impact of the mission accomplishment as a result of delaying a year. I believe it does accomplish a certain part of their mission but I think there is still a delay from the original Galileo which used the long-tank Centaur. But, much of the risk, with regard to development, would tend to go away with a year's delay.

The problem that we saw at that time with going with a 1985 date was such that we would not have the opportunity to design a sufficient model of the Centaur to check out the vibration and the environment which our payloads would have to operate on the front of the Centaur before the time which we would have to commit to the development. So, we foresaw a significant risk in

schedule which we could not tolerate and a significant uncertainty in the cost to modify our payloads to accomodate the Centaur peculiar characteristics of the shakes and the rattles to the point where we felt it was unacceptable for national security reasons to accept a commitment to essentially proceed with a 1985 launch for Centaur. That was a position that we could not tolerate at that time.

Now, given additional time, a year or so, which we could in fact work out those technical solutions and problems and accept the new environment under which our payloads would have to operate on the front of the Centaur, that would be a much more acceptable position for us and possibly we could have proceeded on with a joint program with a short-tank Centaur. That was a position that I discussed with Mr. Beggs and for his own reasons and for NASA's mission reasons they claim that that was an unacceptable delay in the Galileo mission and it would decrease the rationale for proceeding with the preciseness of a Centaur. It would open up the question of whether we should have had a joint or competitive development for that stage in which Centaur and others could compete and that, of course, would have delayed the time a little longer.

Mr. LOWERY. How much longer?

Mr. FLIPPO. I want to assure the gentleman from California that he will have adequate time to seek answers to his questions. We will not cut that off. It was the intention of the Chair to recognize another gentleman from California, Mr. Brown, and Mr. Winn and then come back to the gentleman from California.

Mr. WINN. Mr. Chairman, thank you. I was just going to yield my time to the gentleman from California on this side but I know the other gentleman from California was ahead of me.

Mr. FLIPPO. The Chair recognizes the gentleman from California, Mr. Brown. Everyone is very interested in this line of questioning, Mr. Lowery. Please feel free to proceed.

Mr. LOWERY. The courtesy of my colleagues is most gratifying. How much time would that possibly extend competition?

Mr. ALDRIDGE. I would imagine that if we started with a set of requirements it would be 6 months before we could get a decision. I am speculating at this point because I really have not laid out a time line. You may even be able to do it faster, but more than likely it would have taken longer. But, if we delayed the time I am sure there would have been companies who would have come forth and said "I could have my stage available as the Centaur would have been available " if we slipped the first launch until late 1986. We would then have had to go through the competition and the evaluation and the contract award and it would probably have slipped at least a year.

Mr. LOWERY. A year or beyond?

Mr. ALDRIDGE. Probably beyond the late 1986 timeframe. It would probably have slipped back another 6 months.

Let me just make a point. You have to recognize that the schedule to meet the 1985 launch for Galileo was a very short schedule. We were talking about delivery—from goahead to delivery of a stage—in about 3 years. Recognizing that the Air Force buys Trans Stages for fitting on top of our Titans that are already in production that take 3 years to build, and these are production units not development and production units. So, there was a little bit of opti-

mism, I believe, in some of the contractor quotes as to how fast they could develop and deliver that particular stage.

In spite of that, I think maybe we could have made it done—we keep trying to reduce the times for getting things done—maybe we could have made it. I think that the risk—schedule and cost risks—on DOD payloads was one that drove us off of that design, especially since the IUS, which was already in development and anticipated production, could meet our requirements.

Mr. LOWERY. I think that with any new bird that kind of—I may have been overly optimistic but I think when we are looking at the past record of a Centaur—over 60 missions flown and out of the last 33 over the last 8 years, 100 percent success, and I know that there would be modifications and the like——

Mr. ALDRIDGE. But there still is a development cycle required and compared to things we are now producing the same lead time.

Mr. LOWERY. Your discussions with Mr. Beggs, did they take part, for the most part, prior to your February 11 memo to Secretary Orr and have you had further discussions since the Air Force has more definitively focused our needs for 10,000 pounds to geosynchronous orbit in 1987? With NASA?

Mr. ALDRIDGE. We have had quite a few discussions with NASA, not specifically with Mr. Beggs, but we have talked about proceeding on with this joint effort and in fiscal 1982 to define those requirements in a more definitive way and to lay out a program plan by which we could, in fact, carry out a high energy upper stage development.

Mr. LOWERY. When NASA made the decision—possibly this should be directed toward General Abrahamson—when NASA made the decision not to go with Centaur because they had trouble amortizing the costs over two missions, was the commercial need factored in and the fact that a number of U.S. contractors are looking elsewhere for needs in the late 1980's?

Mr. FLIPPO. General Abrahamson, would you mind joining the witnesses at the witness table please. It would be very helpful.

Mr. ALDRIDGE. We are delighted to have him here.

Mr. LOWERY. Share the fun. [Laughter.]

General ABRAHAMSON. Specifically, the answer is that we only have the two known mission requirements at this point in time. I have often heard Mr. Beggs and Dr. Mark express concern for the ability to have a high energy upper stage in order to meet user concerns but we do not have, to my knowledge, a specific set of requirements from some of the communication satellite builders. I recognize that as a shortfall and just this morning in fact I signed the action for letters to go out to the communication satellite users and the builders so that we can get a better definition of what that requirement is.

Mr. LOWERY. How soon will you have that?

General ABRAHAMSON. I hope to have the letter out in a day or so. How fast they will be able to respond is another question.

Mr. LOWERY. Thank you. As I understand it, a number of contractors are already seriously along their discussions with Ariane.

General ABRAHAMSON. Yes, sir. I am aware that here are discussions and plans that are going on but what I do not know is exactly how specific, in terms of timing. For example, the larger Intelsat

vehicles will clearly be vehicles in order of magnitude requiring 8,000 pounds to that goesynchronous orbit. What I do not know is the specific timing that is being discussed between the user companies and Hughs and other corporations that are building these. So, specifically, we only have the two requirements but we are aware and concerned with the other longer term requirements by the company.

Mr. NELSON. Would the gentleman yield?

Mr. LOWERY. Sure.

Mr. NELSON. General, you might consider this. We have made an enquiry of NASA and have heard an estimate of an additional $120 million that it would cost NASA to operate the mission to Galileo for those extra 2 years—a 4-year mission instead of a 2-year mission by using the IUS—and if you could still operate the mission in 2 years by doing the Centaur, even if you delayed it until 1986 and it still got there in 1988 ahead of time, then NASA might want to reconsider its position if the cost is going to show that you are going to incur an additional $120 million.

We made a call to NASA to ask what would be that figure and that is coming out and we can supply you with the office that it came from and so forth, but I would appreciate it if you would check that out.

General ABRAHAMSON. Yes, sir.

Mr. LOWERY. Mr. Chairman, I have no further questions. I think that every member of the committee is quite anxious to get some further light shed on a joint program—possibly slipping Galileo a year or less and factoring in all the costs and comparisons and see where we are going to be in the latter half of this decade in terms of a much greater capability and what the impacts will be on the taxpayer as well as a much greater capability to the commercial sector as well. As soon as you all can get back to us with that, I know about eight members of this committee who are waiting with baited breath.

Mr. FLIPPO. Mr. Secretary, last year, in testimony before the committee, the Air Force had some concerns about whether or not the IUS could be made to work. Do you still have any concerns as to whether or not the IUS could be made to work?

Mr. ALDRIDGE. No, sir. It seems that the technical performance estimates on the IUS right now are meeting their expectations. We are not very pleased with the costs that have been incurred on the IUS, it is not one that we look upon with great pride but I think as far as technical performance is concerned and the schedules that appear to be coming out of the program now, we can meet our requirements with fairly high competence.

Mr. FLIPPO. Last year the Air Force stated that the first need date for performance augmentation capability was 1987. We now understand that that is 1985. Can you elaborate on this change of requirement?

Mr. ALDRIDGE. I am not aware of the 1987 date for the thrust augmentation.

Mr. FLIPPO. That was the testimony before this committee last year on the part of the Air Force.

Mr. ALDRIDGE. The thrust augmentation date that I am aware of is the first launch from DOD payload out of Vandenberg in October

of 1985 which is the mission that I have talked about before which is included in my prepared statement and that we need that thrust augmentation to regain the capability that was once advertised for the Shuttle to do that mission.

Mr. FLIPPO. Mr. Secretary, could you shed any light on why the joint Air Force/NASA study conducted last year failed to identify the DOD/intelligence requirements for a high energy upper stage?

Mr. ALDRIDGE. All the requirements for the Department of Defense, including intelligence requirements, were included in that study.

Mr. FLIPPO. Well, I hear you now saying that you are going to conduct another study in the future—you are going to look at that—and yet you and NASA just concluded and reported a study——

Mr. ALDRIDGE. I understand. The requirements that were identified and are still firm within the Department of Defense through the late 1980's can still be met with an IUS. As we proceed on in looking out into the future with a little more definitive and a few more months under our belt, we are beginning to see additional demands—nothing firm at this point in time—but additional demands being placed upon our payloads for more requirements, such as survivability, which may include additional weight, trying to harden satellites, trying to make them more survivable against potential enemy attacks and put additional payloads on them.

Still, at this point in time, if I try to find the firm, hard requirements that I can grab a hold of to say what weights are required through the 1987 or 1988 timeframe, IUS can still meet those requirements. But, as we try to be a little more foresighted in our requirements generation, we do begin to see pressures to increase those weights of satellites and so we thought it would be prudent to begin a study to see what are the requirements which is part of this $4 million, so that, in fact, we can meet those demands for the future.

Mr. NELSON. Will the chairman yield?

Mr. FLIPPO. I will be delighted to yield.

Mr. NELSON. Now, let me make sure that I understood you, Mr. Secretary. You said that it is your intention that with IUS, not the high energy upper stage, that you can meet your requirements in the 1987-1988 timeframe?

Mr. ALDRIDGE. Yes, sir.

Mr. NELSON. And that is with about 5,000 pounds?

Mr. ALDRIDGE. Yes, sir. There are some requests from the payload people to go a few hundred pounds more than that, but that is within the capability of the existing IUS. We can make some small changes to get that few hundred pounds.

Mr. NELSON. Five thousand pounds plus a few hundred?

Mr. ALDRIDGE. Fifty-three hundred.

Mr. NELSON. Why did you state in a memorandum, signed by you February 11, 1982, which says, "accordingly, please initiate a program for fiscal year 1987 of a Shuttle compatible vehicle which will be capable of placing about 10,000 pounds in geosynch."?

Mr. ALDRIDGE. That is a request to begin the study as we see those demands being placed on our satellites for those timeframes. We could anticipate—and I underline the word, "anticipate"—

weights of satellites growing to the order of 10,000 pounds and even more.

Mr. NELSON. Anticipate that need in fiscal year 1987?

Mr. ALDRIDGE. For launch in late 1987 or early 1988. Yes, sir, we could anticipate. Now, what those requirements specifically are is part of this joint study.

I recall that within that memo those were guidelines for initiating the study. We have to get some ground rules for doing such a study and that was what that memo was all about.

Mr. NELSON. Well, I am just a little country boy from Central Florida but it seems that I recall a little bit earlier here in your testimony that you are talking about not going to have that increased poundage capability under the high energy stage until 1988 or 1989.

Mr. ALDRIDGE. No, sir. I said——

Mr. NELSON. You think you could have it in 1987?

Mr. ALDRIDGE. We would hope that we could begin a study that would give us that capability by the late 1987 period, yes, sir.

Mr. NELSON. If underlying all of this there is some intelligence reason or defense reason that you have got to have solids out there instead of liquids, you know, then we need to know that in some private discussion, but if that is not the case, and I assume that it is not the case because I ask you the question, "could Centaur perform your mission" which is liquids, and you said "yes". So, if that is not it then we just want to make sure that we are going in the right direction with regard to the cost.

Mr. ALDRIDGE. I do not understand why Centaur would not be a leading candidate to meet that requirement as specified in that memo.

Mr. NELSON. So you develop a solid IUS and then you go with Centaur on a high-energy upper stage?

Mr. ALDRIDGE. Conceivably.

Mr. FLIPPO. If I might—yes, I would yield to the gentleman from California.

Mr. LOWERY. Mr. Chairman, I do not mean to cut you off.

Mr. FLIPPO. That is perfectly all right.

Mr. LOWERY. I just wanted to follow up on Mr. Nelson's question. I think we have kind of come to that conclusion as well and if, for some reason, we can accelerate the development and we can save the taxpayers a great deal of money, possibly that needs to be looked at. With the report that the chairman has asked for in terms of the cost comparisons and looking at the total picture, including possibly slipping Galileo a year, projecting those costs out through about the midnineties, let us see where we come down.

Mr. ALDRIDGE. Yes, sir. Well, realizing that when you slip and force us to pick up the Galileo or the Centaur for the 1985 period and force us then to cancel out the production for the IUS we have to provide additional costs like modifications for the Shuttle, additional costs for the transition between IUS and Centaur and then the uncertainty of the cost of modifying all the DOD payloads to go on top of that in the near-term.

Mr. FLIPPO. Mr. Secretary, I am interested in pursuing just briefly the study that you intend—you and NASA—to do. I wonder if you could tell us something about the framework for this proposed

joint effort, for the record. You and NASA may wish to reply to this. Are you talking about an equally funded, new, high-energy upper stage?

Mr. ALDRIDGE. It really is undefined at this point. The first increment of the funds—the $4 million—will, in fact, be Air Force funds. It will be a joint effort, run from the space division in California with NASA participation. The actual mechanics of how that is to be done is still being worked out. General Abrahamson will be involved, certainly with staffing with Air Force people to do that. The Air Force would pay for the $4 million. NASA is, in fact, talking about spending some additional funds of their own to make sure of the compatibility of that stage with the Shuttle and so forth.

Beyond that point, it would depend on what the definition of the stage would look like. If, in fact, it would look like a Centaur, perhaps because NASA has been very much involved with the development of that, it could be taken over by NASA, or, if it were a new upper stage of some sort it might be taken over by the Air Force. How that will proceed will depend upon what the definition studies conclude and how much existing technology versus new technology will implement. But, I think we have a very good working relationship within NASA and our Air Force on this issue and I do not anticipate any problems in working out any particular difficulties whatsoever.

Mr. FLIPPO. General, would you care to comment on the study that NASA and the Air Force concluded in November—it was presented to the committee, I believe, in November of 1981, signed by Dr. Mark and the Secretary of the Air Force. Would you care to comment on why that did not care to define or identify NASA requirements, or, is it your opinion that it did? Do you see a need for the new study, I guess is what I am asking?

General ABRAHAMSON. If I may, sir, since I was not with the agency during that period, I would like to defer the question to Mr. Weeks, my deputy who was very closely involved in that study and then I will answer the second part, if I may.

Mr. FLIPPO. We would be pleased to have the gentleman's response if he cares to make one.

Mr. WEEKS. Dr. Charles Cook and myself were the co-leaders of that about 7-month study to define those requirements. We, indeed, got some comments from the Comsat world in the 8 to 10,000 pounds in about the 1989/90 class of timeframe. The conclusion, which I am sure you are very familiar with, which concluded to continue with the IUS and DOD and the Centaur for us was a solution that, as I saw it, pretty clearly met whatever I could see on the horizon of the Comsat world and, of course, we reviewed that very carefully with Mr. Stofan who is the head of the space science world and clearly met the requirements of Galileo, ISPM, VOIR, and others that were more comet oriented, and so forth. But, they were all essentially met by the program that we started on May 1, which was the long, wide-bodied Centaur. So, the conclusion of whether we were missing out with anybody that was ours was appropriately handled because there was a good answer there that met any needs that we could see on the horizon.

Dr. COOK. I might add also that in the projections that we were making at the time that Mr. Aldridge has spoken about that we thought the Centaur or a slight modification to that would handle the Air Force needs too and that is why the joint recommendation was made that we stay with the IUS until the Centaur, as developed by NASA, would be available. That seemed, at the time, to be a good solution.

Mr. FLIPPO. I do not wish to belabor the point too much. I might ask Mr. Weeks if he could tell me why NASA—first of all, does the short-bodied Centaur meet NASA requirements, and if not, why would NASA agree to the short-bodied Centaur?

Mr. WEEKS. As I spoke in the record the other day, we went from May until about November—Thanksgiving—because the long wide-bodied Centaur, as that November 2 letter, signed by Mr. Orr and Dr. Mark, met our requirements very well, we did not have to have any additional stage for ISPM at all, we avoided that completely, which is a significant development. We like to avoid extra stages when we can. That is only prudent to the design of launch vehicles, space vehicles, and so forth. So, it was a very clean answer for us, for Galileo, and met the window very nicely on April 12, 1985, which is when the direct window going to Jupiter opens, and it is open only for 20 days or so. So, that was a very elegant answer for avoiding this 2-year delay that, I believe Mr. Brown or Mr. Nelson spoke to. Then, in that November/December time period, the short, wide body was discussed and we knew, Dr. Cook and I were fully informed, about the longer payloads of the DOD. At that juncture, just to follow up Secretary Aldridge's point is that we knew of that and that was not, at that juncture, a hard requirement. The planning at that juncture, if there was a need for the short, wide-bodied Centaur, was that it would be funded and we would proceed for that requirement.

The short, wide body, as I believe I spoke the other day, was a good compromise in our view at the Christmas time period, to meet this thing even though it made some of the NASA missions less perfect.

Mr. FLIPPO. General Abrahamson, I believe you were going to comment on the need for a future study, sir.

General ABRAHAMSON. Given where we are today, sir, I believe that, in fact, it is vital that it be a joint study and as a result I did go back, search our 1982 budget and to see if there were some moneys that we could squeeze out. We thought it was a very important step that the Department of Defense was able to locate candidate items that they would send for reprograming so that we could have some initial funding basis on which to start this effort.

Obviously, we did want to fully participate and it appears at this point that we can make approximately $1 million or so from our 1982 budget for this purpose. I have discussed that and made that commitment to General Randolph and Mr. Beggs is in full agreement with that. So, given that we now need to proceed on this joint basis, I see that it is vital that it is, in fact, jointly funded in the study phase. Again, Mr. Aldridge indicated that whatever the final outcome might be, as well as I am sure administration policy on funding, will be a factor in terms of how a program might be funded.

Mr. FLIPPO. Would it be NASA's intent and the intent of the Air Force to have a competitive procurement?

General ABRAHAMSON. That is our intent. Yes, sir. I think there are quite a few advantages to that, sir.

Mr. FLIPPO. Thank you. Mr. Secretary, could you elaborate on any DOD plans for development and demonstration of a 30/20 gigahertz technology. The committee is looking at that and the committee would need to know——

Mr. ALDRIDGE. I would like to have General Randolph address that question.

General RANDOLPH. We are, in fact, working at several VHF frequencies, including the 30/20 gigahertz work. We are working that, by the way with NASA and we have had considerable interchange with the NASA people on that particular issue.

Mr. FLIPPO. Is the Air Force proceeding with a demonstration of that technology?

General RANDOLPH. We are proceeding with a demonstration of that technology at the 44/24 gigahertz. However, the technology at 30 gigahertz is really about the same.

Mr. FLIPPO. And would that technology developed in the Milstar program be available for commercialization.

General RANDOLPH. Yes, sir.

Mr. FLIPPO. I would like to know whether the Air Force would be willing to acquire some additional Shuttles.

Mr. ALDRIDGE. As I mentioned before, it is important for us to consider the procurement of additional Shuttles. As you realize, back when the agreement—I believe it was 1977—when there was an official memo of understanding that NASA would, in fact, procure five Shuttles and operate the Kennedy facility and the Air Force would pickup its share of the burden by building a new launch facility at Vandenberg and and do the development for the IUS plus the payload integration for the Shuttle program. At that time we figured that was a fair split. Now, lots of things have happened since that point in time and, obviously, the cost of a Shuttle and the cost of space operations in general have gone up to the point where the fifth orbiter is still a somewhat tenuous system, we fully support the procurement of that orbiter. We feel, in fact, that it is a national program. The whole Shuttle activity is national and the taxpayers, in fact, should pay for it. I think we would be reluctant to try to find an offset in the Department of Defense at this point in time to pay for an additional orbiter, but I think, as a taxpayer, that the country should pay for an additional orbiter.

Mr. FLIPPO. Mr. Brown.

Mr. BROWN. Thank you, Mr. Chairman. I do not want to carry this on too extensively but the thrust of the questioning this morning raises a somewhat broader question which is of deep concern to me and the committee as a whole, I think. That being that we have in the Defense Department a rather sound budgetary situation and budgetary projections and as a result of well-developed strategic planning capability in this area, we have at NASA—we have a much less secure budgetary situation—ambiguity as to the future role down the line—and within what you might call the commercial space future, we have no strategic planning capability that I know of and considerable uncertainty as to what is going on. Now,

in this kind of a situation, it is obvious that the Department of Defense becomes a driving force in terms of the long-term planning for space development. The assertion is made occasionally that NASA looks like it might end up just being a trucking company for the Defense Department. I am concerned very much about the future of our space science, planetary exploration, which have an uncertain future at this point. I am equally concerned with the future commercial developments in space, near Earth and what this means to the prestige and the economic status of this country.

Now, these are the other broader kinds of problems illustrated by much of the questioning that has gone on here this morning. I wonder if you could comment with regard to this; whether you see it as a real problem and what direction you see the solution.

Mr. ALDRIDGE. I am not sure I am foresighted enough to see the solution. Let me comment on a couple of points that you made. One is that the health and status of the Department of Defense—I guess the implication is why does the Department of Defense not take over more of the responsibility for funding certain aspects of the Shuttle program——

Mr. BROWN. That is not really my position here although it is one of the subsidiary questions.

Mr. ALDRIDGE. Well, let me address that question. Most people take a look and say, "Well, the Department of Defense is over $200 billion and NASA is $6.6 billion." Obviously, it is easy for us to fit in a few hundred million dollars more in the Defense Department. In the space activities it is not that way at all. It is $6.6 billion in NASA versus less than $3 billion in the DOD space program. So, we are trying to take a $6 billion program and fit it into a $3 billion program, unless you want to cut back on readiness, or modernization, or strategic forces, or something like that, and I do not think that is the intent.

As far as the future goes, the Department of Defense is going to take over a great deal of responsibility. The Air Force will take over the responsibility of launching DOD payloads so that part of the operations will, in fact—that burden—be shared by the Department of Defense and, in particular, the Air Force, which will have that responsibility.

As you know, part of the facility at Johnson is being modified so that we can, in fact, take on the security aspects of launching the Shuttle with DOD payloads onboard and that will eventually transition as the DOD payload increases in the out years to be held by the CSOC which will be built at Colorado Springs. So, some of that function of launch operations will, in fact, be absorbed by the Air Force.

To what extent that goes beyond just DOD payloads is a subject of study that is underway right now as part of Jay Keyworth's national space policy study of what is the management philosophy for the future with regard to launch operations. Should the Air Force and the Department of Defense take over all launch operations for Shuttle or should NASA be the launch service organization or should some other ad hoc agency take over that responsibility and that is a subject that is a national space policy issue and, quite likely in the office of the President. So, that is being done.

As to the future, it is a little more uncertain as to the commercial, competitive nature of the Shuttle operations and other things. It is kind of hard for me to address that particular concern. I have a concern as a taxpayer that we would lose our competitive edge if we do not do or make the right decisions with regard to keeping the competition alive.

Mr. BROWN. Do you see any security implications from our becoming a second-rate power in space and space science?

Mr. ALDRIDGE. There is no doubt in my mind that we will never become a second-rate power in space.

Mr. BROWN. Are you thinking primarily of military space or all space?

Mr. ALDRIDGE. I am thinking of all space, but primarily military.

Mr. BROWN. Let us look specifically at the Milstar program and the communications technology research. We had testimony yesterday, I think, that NASA is having to give that up. They are not going to be doing 30/20 gigahertz research, advanced communication research in that area, despite its very great importance to the commercial development of communication satellites. I hope that means that they have reached an amicable understanding with you, that you are going to do all the things that need to be done, it is going to be available for commercial exploitation and lead to the continued preeminence of this country. Can you assure me that this will be the case?

Mr. ALDRIDGE. The Milstar program is becoming one of the most important military communication satellite programs and is receiving all of the highest-level attention at this point in time. General Randolph, who has been following that about 24 hours a day can speak to that better than I, but I assure you that it is, as far as the leadership in the Department of Defense is concerned, will be the primary military communications satellite and will receive all the priority and attention that it needs and deserves.

Mr. BROWN. As a military project?

Mr. ALDRIDGE. To the extent that that technology can be transferred into the commercial field, we certainly will do that, with all of the ramifications of security.

Mr. BROWN. You understand our concern that the huge civilian commercial implications of this project are represented by a declining or zero budget in NASA and the full responsibility of the development apparently is turned over to the Department of Defense.

Mr. ALDRIDGE. Well, General, do you want to take a shot at that?

General RANDOLPH. Well, I think that what history will show is that the current commercial communication satellites were developed as a result of the technology work that was done in the Department of Defense. Intelsat, for example—at least the Hughes version—was a direct result of a Department of Defense satellite and we have full intention of making sure that the technology that we develop is commercially available to the maximum extent possible as far as security is concerned, and certainly, that basic technology is always available, sir. So, I think the answer is yes, sir, we can assure you that that will be available.

Mr. BROWN. I have confidence that what you say is correct because I know that you are not doing the work, that Hughes is doing the work, or some other private company, and they are going

to look for the private market to exploit. But, the point that I am mostly concerned with is that the policy planning, the long-run development guidance is not coming from a civilian agency, but is coming from a military agency and this bothers me because I know that in other countries which are competitors the developments in this area are driven by as much or more by their anticipation of future commercial prospects in this area and it may give them an edge as far as we are concerned. I am speculating a little. I am not close to the field but it is a worry. Maybe it is because we are the civilian science committee and not the Armed Services Science Committee, I do not know.

I have no further questions, Mr. Chairman.

Mr. FLIPPO. Just a point. We had witnesses yesterday, General, who testified that the military program would not satisfy the commercial sector requirements in regard to that, just for information purposes. Also for information purposes, I am sure you know that NASA also claims that the current good state of the communications industry comes from their research.

I know that every member of this committee joins with me in thanking you for your testimony and your patience in helping us understand this difficult area. I hope that in this joint study that you are undertaking that that will certainly involve the administration's new space policy considerations and I hope that it will also involve some very detailed cost studies, not just whether we need it or not, but some meat on the bones.

[Additional answers to questions asked of the Air Force follow:]

DOD MILSTAR PROGRAM

Question. Could you elaborate on DoD plans for development and demonstration of 30/20 gigahertz technology? (DoD MILSTAR program)

Answer. The MILSTAR program plans to use 44/20 gigahertz technology to provide highly jam-resistant communications to strategic and tactical users of all Services. Technology efforts have been underway in the Advanced Space Communications Program (PE 63431F) for a number of years. A major milestone in this frequency regime was the successful operation of Lincoln Laboratories Experimental Satellite 8 and 9, launched in 1976.

Technology work is also underway to support 30 GHz uplinks. This effort is targeted at a possible upgrade to the Defense Satellite Communications System.

TECHNOLOGY IN MILSTAR PROGRAM

Question. Will technology developed in the MILSTAR program be available for commercialization?

Answer. The basic technology developed by the MILSTAR program can be made available to support commercial application. We will seek to minimize the restrictions on transfer due to security considerations.

DOD/NASA COORDINATING ACTIVITIES

Question. DoD and NASA coordinating space communications R&D activities?

Answer. Yes. The Air Force's Advanced Space Communications Program, PE 63431F and NASA's Lewis Research Center are coordinating on 30/20 gigahertz technology. NASA is leading the development for the next generation domestic communciations satellites and the Air Force is leading the development for future military systems with their unique anti-jam requirements.

STATUS OF AIR FORCE/NASA DISCUSSIONS

Question. What is the current status of Air Force/NASA discussions related to a high energy upper stage?

Answer. We are initiating a joint study to define requirements for a Higher Energy Upper Stage (HEUS). AF funding for that study is contained in the fiscal year 1982 IUS reprogramming request. The HEUS is planned for the 10,000 lbs to geosynchronous class and a late fiscal year 1987 IOC.

IUS/HIGH ENERGY UPPER STAGE

Question. (a) What are the Air Force current plans for development of a high energy upper stage? (b) Do you envision a joint NASA/Air Force development? (c) Will the Air Force development accommodate NASA planetary requirements?

Answer. (a) The Air Force plans to initiate a program to develop a Higher Energy Upper Stage (HEUS) with a joint NASA/AF study in fiscal years 1982/83 to define requirements. Assuming the availability of funding, full scale development would start upon the completion of the study and the appropriate reviews and approvals by the Air Force and the Office of the Secretary of Defense. The target operational capability date is late fiscal year 1987.

(b) The requirements definition study will be conducted jointly. A decision on the appropriate management structure for the HEUS will be made based upon the outcome of the requirements definition process.

(c) The HEUS program will consider all NASA requirements in the requirements definition study.

NEED DATE FOR HIGH ENERGY UPPER STAGE

Question. What is the Air Force need date for a high energy upper stage?

Answer. The anticipated requirement is late fiscal year 1987, which is the target operational capability date for the Higher Energy Upper Stage.

FAILURE TO IDENTIFY DOD/INTELLIGENCE REQUIREMENTS

Question. Could you elaborate on why the joint Air Force/NASA study conducted last year failed to identify DOD/Intelligence requirements for a high energy upper stage.

Answer. The joint Air Force/NASA study delivered to the Congress on 2 Nov. 1981 included all DOD/Intelligence requirements.

COMPETITIVE PROCUREMENT FOR HIGH ENERGY UPPER STAGE

Question. Does the Air Force plan to pursue a competitive procurement for a high energy upper stage?

Answer. Yes.

COST TO COMPLETE ESTIMATES FOR IUS DEVELOPMENT

Question. What is the current Air Force/NASA cost to complete estimates for the IUS development?

Answer. The NASA portion of the Inertial Upper Stage (IUS) development (the planetary variant of the IUS) has been terminated. The Air Force has the only continuing development task: the completion of the standard, two-stage IUS development. We estimate $110M to complete this task and have the necessary funds budgeted in fiscal years 1983 and 1984.

IUS SUNK COSTS

Question. What are the IUS sunk costs?

Answer. Sunk costs for the Inertial Upper Stage (IUS) are summarized below: Development program (Air Force) through fiscal year 1982—$509 million; development program (NASA) through fiscal year 1982—TBD; long leads for first production buy—$108 million.

The Air Force development program includes the costs for the ongoing standard two stage IUS development and the four DOD vehicles procured under the full scale development contract (all are now in final assembly and checkout).

The NASA development funding includes those funds for the now terminated planetary IUS development and the four and one-half NASA procured vehicles in the full scale development. The one-half vehicle began as a planetary IUS. When that development was cancelled, only that portion of the vehicle that was common to the standard two stage IUS was continued—resulting in one-half of a vehicle. It will be completed in the first production buy.

Long leads for the first production buy began as long leads for eight vehicles. With the cancellation of the planetary IUS, the total number of IUS vehicles required through the period covered by the first production buy was reduced by four. However, recently NASA reinstated one vehicle to make the first production buy total five vehicles.

IUS PROJECTED UNIT COSTS

Question. What are the IUS projected unit costs?

Answer. Beginning with the fiscal year 1983 buy we project an IUS unit cost of $44M. This is achieved by combining Air Force, NASA, and other DOD requirements into an efficient eight vehicle block buy to be awarded every two years.

However, IUS unit cost for the production buy to be awarded in May 1982 is estimated to be $55M. This award is the first follow-on buy to the IUS vehicles being produced on the Full Scale Development contract. The long lead procurement for this buy began in July 1980 to support eight vehicles. In early 1981 NASA cancelled four planetary configured IUS vehicles from this buy. In January 1982, they reinstated one of these vehicles as a standard two-stage IUS. The revised buy now includes two vehicles for the Air Force, two for NASA, and one for special activities.

ESTIMATED COST FOR DEVELOPMENT OF LONG WIDE-BODY CENTAUR

Question. What is the estimated cost for development of the long wide-body Centaur? What are the additional incremental development costs for a short wide-body Centaur to meet all Air Force unique requirements?

Answer. The NASA estimate for Centaur development is as follows:

	Millions
Stage R. & D. (long wide-body; including sunk costs (then year dollars)	$230
Orbiter modifications	110
Total	340

The precise development cost of meeting DOD requirements depends upon how the requirements are actually implemented in the Centaur program. However, the Air Force estimate (included in the October 1981 NASA/DOD Report to the Congress "Upper Stage Alternatives for the Shuttle Era") shows a range of $145M to $265M (fiscal year 1981 dollars); the difference depends primarily on whether redundant avionics are included. When escalated to approximately the same time frame as the NASA costs shown above, the Air Force estimate for meeting DOD requirements becomes $175M–$320M. In addition, DOD spacecraft modifications would be required to enable launch on a Centaur vehicle; the total cost for this transition for all DOD payloads (based on only very preliminary estimates) would be between $200M and $500M.

PROJECTED UNIT COSTS FOR CENTAUR

Question. What are the projected unit costs for the Centaur? (a) Long, wide-body; (b) Short, wide-body.

Answer. The NASA estimates are: (a) Long, wide body—$53M (then year dollars); (b) Short, wide body—$53M (then year dollars). This includes hardware costs (based on buy of 9 vehicles), typical spacecraft integration, launch services, and NASA "in-house" costs.

These estimates do not include the impacts of adapting the Centaur configurations to meet DOD payload requirements. These include: greater orbital injection accuracy; redundant avionics; spacecraft load alleviation; Orbiter Bay loiter capability; adequate payload length provisions; and other payload/stage interface considerations. The cost to meet these requirements cannot be estimated precisely since the methods of satisfying them with the Centaur vehicle are not defined. However, we have estimated that redundant avionics alone, if included, would add about $16M to each Centaur unit cost.

ESTIMATES FOR ORBITER MODIFICATION COSTS

Question. What are the cost estimates for orbiter modification costs to accommodate the Centaur?

Answer. The NASA estimate is that two Orbiters (099 and 104) can be modified for $110M. This includes both non-recurring engineering and recurring modification costs and modifications to NASA Kennedy facilities (one launch pad and the mobile

launch platforms). No consideration has been given to modifying the other two Orbiters (102 and 103).

MODIFICATIONS TO MEET AIR FORCE REQUIREMENTS

Question. What modifications to the long, wide-body Centaur would be needed to meet Air Force requirements?

Answer. These modifications must be defined in two steps: first, the generic DOD upper stage requirements; and second, the specific technical approaches to incorporate those requirements into the Centaur vehicle.

(a) The generic DOD payload requirements were defined in the Oct 1981 NASA/DOD report to the Congress titled "Upper Stage Alternatives for the Shuttle Era." These included: (1) High accuracy for orbital injection; (2) Maximum launch reliability (i.e., redundant avionics); (3) Spacecraft load alleviation; (4) Orbiter bay loiter capability; (5) Adequate payload length provisions; and (6) Other payload electrical/mechanical interfaced provisions.

(b) The specific technical approaches needed to incorporate these generic requirements into the Centaur have not been defined. This step would require a minimum of 6 months—and more likely 9-12 months to complete. This time period would be used to: put the generic requirements into specific contractual/technical language; define the Centaur-unique technical implementation approaches; assess the ability of those approaches to meet the requirements; and authorize the contractor to proceed. During that time 9-12 month period we would also evaluate the spacecraft program modifications needed to interface with the Centaur, obtain funding, and authorize the spacecraft contractors to proceed with modifications. Only then could a program to modify Centaur be undertaken with confidence.

REQUIREMENT FOR REUSABILITY

Question. Should reusability be a requirement for a high energy upper stage?

Answer. Yes, in the far term. The concept for the Higher Energy Upper Stage includes a modular design allowing incremental upgrades to the system. One such increment could be reusability. That particular upgrade is, however, closely tied to a program for a space station which would make such a system feasible.

CURRENT STATUS OF IUS DEVELOPMENT

Question. What is the current status of the IUS development program?

Answer. The Inertial Upper Stage (IUS) development program is proceeding on schedule for the Sep 1982 launch on a Titan III (34)D and the Jan 1983 launch in the Shuttle. The program is successfully meeting all of its performance requirements in all of the developmental and qualification tests. In short, we believe it will perform as expected when it is launched. The program has experienced significant cost growth. The full scale development contract ceiling is now $700M. We expect to complete the development program somewhat under the ceiling figure.

FIRST IUS LAUNCH SCHEDULED

Question. When is the first IUS launch scheduled?

Answer. The first IUS launch is currently scheduled for September 1982. Launch of this IUS will be on a Titan III(34)D from Cape Canaveral AFS, Florida.

CONCERNS FOR IUS

Question. Do you have any concerns that the IUS cannot be made to work?

Answer. No. The Inertial Upper Stage (IUS) has been completing its development and qualification testing with great success. As an upper stage it is unique in its broad application of high reliability piece parts and redundancy. We believe that the IUS will be a successful vehicle from its first flight.

CURRENT UNIT COST PROJECTIONS FOR IUS

Question. What are the current unit cost projections for the IUS?

Answer. Beginning with the fiscal year 1983 buy we project an IUS unit cost of $44M. This is achieved by combining Air Force, NASA, and other DOD requirements into an efficient eight vehicle block buy to be awarded every two years.

However, IUS unit cost for the production buy to be awarded in May 1982 is estimated to be $55M. This award is the first follow-on buy to the IUS vehicles being produced on the Full Scale Development contract. The long lead procurement for

this buy began in Jul 1980 to support eight vehicles. In early 1981 NASA cancelled four planetary configured IUS vehicles from this buy. In Jan 1982, they reinstated one of these vehicles as a standard two-stage IUS. The revised buy now includes two vehicles for the Air Force, two for NASA, and one for special activities.

ADEQUATE CAPABILITY FOR IUS

Question. Are you confident that the IUS will have adequate capability to launch the Tracking and Data Relay Satellite System?

Answer. Yes. The Inertial Upper Stage (IUS) will have adequate capability to launch the Tracking and Data Relay Satellite (TDRS), since the TDRS weight is the same as the Shuttle/IUS capability—5,000 lbs.

PAYLOAD CAPABILITY OF TITAN/IUS VERSUS SHUTTLE/IUS

Question. What is the payload capability of the Titan/IUS as compared to the Shuttle/IUS?

Answer. The Titan III(34)D/Inertial Upper Stage (IUS) combination can place 4,000 lbs into geosynchronous orbit compared to the 5,000 lbs capability of the Shuttle/IUS combination.

CURRENT COST ESTIMATE OF TITAN/IUS LAUNCH

Question. What is the current cost estimate of a Titan/IUS launch?

Answer. The Titan III(34)D/IUS prime launches planned prior to payload transition to the Shuttle use Titan III vehicles procured as a part of a large buy in fiscal year 1977 and IUS vehicles procured on the IUS Full Scale Development contract. The estimated total unit cost (hardware and launch services) in fiscal year 1982 dollars for the launch of these Titan III(34)D/IUS vehicles is $93.3 million.

Because of the small size (normally two) of current Titan III(34)D buys and the cost growth in IUS production vehicles, the unit cost of any future Titan III(34)D/IUS vehicles will be significantly higher. This cost (hardware plus launch services) in fiscal year 1982 dollars is estimated to be $154.3 million.

TITAN LAUNCH VEHICLE PRODUCTION LINE

Question. What are the Air Force plans for maintaining the Titan launch vehicle production line?

Answer. The Air Force currently plans to maintain critical Titan III production capability thru September 1983. The fiscal year 1983 President's Budget contains funds to procure two sets of Titan III(34)D advance materials to allow the maintenance of critical production capability to be extended to September 1984. Production funding for this extension, if a decision to extend is made, would be requested in fiscal year 1984.

IMPACT OF SCHEDULE DELAYS FOR OV-104

Question. What would be the impact on the Air Force of schedule delays for OV-104?

Answer. We have been actively involved in the decision process concerning the schedule for OV-104. We cannot identify any direct impacts to DOD missions for one year delay in OV-104 given the DOD priority for Shuttle flights. There are, however, indirect impacts which must be considered: Given a one year slip in OV-104, only two Orbiters (OV-102 and OV-099) will be operational at Kennedy during the period that OV-103 is dedicated to Vandenberg activation (Jan-Oct 1985); According to NASA, that period is one of significant increase in traffic requirements for the Shuttle; If OV-104 is delayed, it will not be able to backup OV-099 for the planned IUS flights during that period.

We believe that those indirect impacts would add significantly to the pressure on NASA to divert OV-103 from the Vandenberg activation which would, in turn, not allow us to support the Oct 1985 Vandenberg mission. Therefore, we have supported NASA's desire to retain the original OV-104 schedule.

SIZE OF ORBITER FLEET

Question. What size orbiter fleet do you think we need? Would the Air Force be willing to fund additional orbiters?

Answer. "We," the nation, need to build five orbiters and maintain the capability to produce others while we (a) gain operational experience with the abilities of the

Shuttle, (b) refine our estimates of orbiter attrition and (c) refine the estimates of launch demand compared to traffic capacity of the existing fleet.

No, the Air Force is not willing to fund additional orbiters. NASA is responsible for the procurement of the requisite number of orbiters to support the *national* requirements. That NASA investment responsibility (plus their other investment responsibilities) is balanced by the DOD investment responsibility. Our investment share in the shuttle program is approximately equal to our projected use of the system (both about 30 percent). Further, the large increases in STS flight demand which cause the need for additional orbiters come from the civil sector—not the defense sector whose demand has a much lower projected growth.

AIR FORCE PARTICIPATION IN 1983 SPACE SHUTTLE BUDGET REQUEST

Question. Has the Air Force participated in the Administration's decisions with regard to the 1983 Space Shuttle budget request?

Answer. The Air Force input was considered in those areas where fiscal year 1983 budget decisions affected Air Force responsibilities or programs.

NEED FOR SPACE STATION CAPABILITY

Question. What is the Department of Defense view on the need of man in space or the need for a space station capability?

If the nation pursues a spaced station, should the Air Force or NASA develop the capability?

Answer. Within the Air Force, we believe that as the Shuttle becomes operational it will present new opportunities for developing on-orbit, manned interaction with military payloads for operations, maintenance, servicing and repair. Because, essentially all of the DoD's satellite development and operational experience, to date, has been limited to automated or ground-commanded payloads launched on expendable boosters, we have developed, and included in our fiscal year 1984 POM, an Air Force Manned Spaceflight Engineer (MSE)/Payload Specialist (PS) Program. The purpose of the AF MSE/PS Program is to acquire, train and manage a select group of military personnel who can exploit both the Space Shuttle and its crew capabilities to ensure the success of military space missions. DoD PSs will be selected from the cadre of MSEs and be assigned as crew members to DoD Space Shuttle missions.

The AF MSE/PS Program will be located at Space Division within the Deputy Commander for Space Operations organization. Our goal is to create a cadre of MSEs who will be experts at applying the benefits of manned spaceflight to DoD missions from the design stage through on-orbit operation.

The DoD is working closely with NASA in the definition of requirements for a space station. There are many potential military missions such as C³I, surveillance, on-orbit servicing, maintenance of DoD satellites, R&D, etc., that could possibly be performed from a manned space station. In the near future, as we validate DoD requirements, we will examine the potential cost effectiveness of a space station in satisfying national security needs, leading toward a determination of appropriate DoD support to the program.

If a decision is made to pursue a space station, NASA, with close DoD coordination, should develop the generic capability. The degree of DoD participation, if any, in this development has not yet been determined.

COMPLETION OF SHUTTLE LAUNCH FACILITIES AT VANDENBERG

Question. What is the current schedule for completion of Shuttle launch facilities at Vandenberg? What confidence do you have in this completion date for Vandenberg?

Answer. The initial Vandenberg capability is scheduled to be operational in October 1985. Additional facilities are planned for Vandenberg to expand its capabilities if launch traffic requirements warrant the expansion.

We are confident that the Vandenberg schedule can be achieved and an October 1985 launch supported.

CONSOLIDATED SPACE OPERATIONS CENTER

Question. What is the status of the Air Force plans for a Consolidated Space Operations Center?

Answer. Planning for the construction of the Consolidated Space Operations Center facilities is underway and development and acquisition of equipment is proceeding. The environmental impact analysis process was completed in February

1981. The selection of the Colorado Springs, CO site formally announced in March 1981.

A contract for the facility design was awarded in February 1981. The Architect and Engineering firm is now proceeding to the 60 percent design point. Acquisition planning efforts for technical systems have been initiated by the program office in Los Angeles. The contract for the system integrator is currently in source selection. Contract options have been negotiated as part of the Satellite Control Facility Data System Modernization contract for CSOC satellite control systems procurement starting in fiscal year 1983.

Agreements have been negotiated with NASA for the definition/design of Shuttle control systems. Construction of the Defense Satellite Communications System ground terminal located on the CSOC site is scheduled to begin shortly. Responsibility for operation of the CSOC has been assigned to the Deputy Commander for Space Operations at Air Force Systems Command Space Division.

FUNDS FOR CONSOLIDATED SPACE OPERATIONS CENTER VERSUS OTHER

Question. Would not these funds be better used for additional orbiters or a new high energy upper stage?

Answer. No. The Nation's military effectiveness depends on a balance of capability between mission areas. Additional orbiters and/or a new higher energy upper stage may be needed in the future to enhance our overall launch capacity. However, the Consolidated Space Operations Center (CSOC) addresses current deficiencies in our present satellite control network and overcomes limitations in the ability of the Johnson Space Center to conduct classified DOD Shuttle missions. It is the judgment of the Air Force that the CSOC is warranted now to insure continuity of the satellite control functions needed to maintain on-orbit missions and to significantly enhance the ability of the DOD to exploit the Shuttle for military operations.

Mr. FLIPPO. Thank you gentlemen very much for your testimony.

Our next witness is Mr. Wilfred Mellors, Head of the Washington Office of the European Space Agency, who is representing Mr. Erik Quistgaard, Director General of the European Space Agency, who will be discussing ongoing NASA/ESA cooperative programs.

We appreciate your patience as well. Our previous witnesses have taken a considerable amount of time. I might encourage the gentleman to summarize as best he sees fit in the interest of time since we do have other witnesses as well.

We are so pleased that you could come and testify for us. We will take your full statement for the record so please feel free to summarize.

STATEMENT OF WILFRED MELLORS, HEAD, WASHINGTON OFFICE, EUROPEAN SPACE AGENCY, ACCOMPANIED BY IAN PRYKE, ASSISTANT TO THE HEAD, WASHINGTON OFFICE, EUROPEAN SPACE AGENCY

Mr. MELLORS. Thank you very much, Mr. Chairman. I will try to be brief, but I was given a text. Perhaps you will forgive me if I do take too long.

Mr. Chairman, first, my Director General wishes me to express his sincere regrets at being unable to appear before the subcommittee in person and to thank you for agreeing to a substitute. I should also add that he will be happy to answer in writing any questions from the subcommittee which I am unable to answer orally.

The statement from the Director General is as follows [reading]:

Mr. Chairman, I am most grateful to you and your colleagues for the invitation once again to testify before your committee. It is both an honor and a pleasure for me to have this opportunity to inform you on the present status of ESA's cooperative programs with NASA.

As I did last year, I wish to start by stating categorically that ESA and its member states remain fully committeed to the principle of cooperation with the United States in space activities.

This year I believe it is appropriate to start with Spacelab, which, as you know, is the largest cooperative space program ever undertaken. The R. & D. of this program successfully passed a very important milestone toward the end of last year when the first flight unit was handed over to NASA. As you know, Mr. Chairman, NASA very recently formally acknowledged the delivery of this unit by a ceremony at the Kennedy Space Center which was attended by the Vice President of the United States, members of the U.S. Congress, and many other dignitaries. I am pleased to say that this demonstration of the importance placed on the ESA cooperation by the United States has been noted and appreciated in Europe. I must also point out that throughout the development, NASA has actively supported ESA.

Returning to the program itself, flight configuration 2 will be delivered to NASA later this year, as will the European experiments which are to be flown on the first Spacelab mission. Last year, I expressed some apprehension that higher Shuttle/Orbiter loads would require modifications to Spacelab, in particular, the instrument pointing system. This year, I am pleased to inform you that the situation is much brighter. The necessary modifications to Spacelab itself have been effected, and the instrument pointing system has been redesigned. We are confident that this redesign will be successful and that it will be possible to deliver the flight model in time for the SL–2 mission within our cost ceiling. The cost to completion of the whole Slacelab program is at present estimated at about $900 million.

As you know, sir, NASA, in accordance with the Spacelab Intergovernmental Agreement, has contracted with ESA for the purchase of one additional set of Spacelab hardware. Production of this unit is going ahead smoothly and will be delivered in due time.

The Spacelab agreements run until at least 1988. It is, therefore, worthwhile to spend a few minutes looking into the possibilities of further cooperation in this field. Recently, the ESA Council passed an enabling resolution for a retrievable carrier program. I should perhaps explain that in the ESA scheme an enabling resolution is very roughly the equivalent of a NASA authorization bill, but for a single program. This retrievable carrier, which may be based on the Spacelab pallet, having been carried into orbit by the Shuttle could be left in orbit for 1 to 6 months. It would then be retrieved by the orbiter and brought back to Earth.

The advantages of such a free flying carrier are, of course, its ability to remain in orbit for much longer than the Orbiter and its very low levels of gravity and contamination. The carrier will first be used for a microgravity mission which has already been approved, but it will be capable of being used for many other applications. I expect to have financial approval for this program within the next month. In this case, the first mission could take place in 1986 or 1987. I believe this carrier offers possibilities for a continued United States/European cooperation, and I have written to Mr. Beggs suggesting the initiation of working level discussions on possible U S. utilization of the carrier.

At the same time, we are also keenly interested in the studies being carried out by NASA on both manned and unmanned space platforms. We believe that, should programs based on these studies be approved, utilization of the expertise developed in Europe through the Spacelab program and the adaptation of Spacelab components for incorporation into such platforms would be entirely within the spirit of the current agreements.

Turning to space science, with one exception, our cooperative ventures in space science are going well. The International Sun Earth Explorer program, the International Ultraviolet Explorer program, and the Space Telescope all are doing well and I do not think they require any further comment.

I must now turn to ISPM. Here, first, I wish to express the appreciation of the Agency for the efforts made in Congress and, in particular, in your subcommittee during the past year to preserve the two satellite program. The present situation is, of course, that the fiscal year 1983 budget proposal does not make any provision for the U.S. satellite and the 11 member states of the agency have submitted to the State Department (at Ambassador level) an aide memoire expressing their "profound regret at this decision." The decision does, of course, mean that the efforts and funds expended by the scientists, both United States and European, with experiments on the NASA spacecraft will now be wasted.

On our side of the Atlantic the science program committee of the Agency has decided to proceed with the ESA satellite and to maintain its original experiment complement. The scientists with experiments on board the European satellite will, therefore, be unaffected. In view of this we are naturally most anxious that NASA

will be able to honor its remaining commitments in the program. Hence, we are pleased to see that funds for this are included in the fiscal year 1983 proposal. I venture to express the hope that Congress will be able to maintain these funds in the final bills, but I must point out, that as now planned, the ISPM program will last until 1989 and that there still exists some unease regarding the future.

Lastly, in the field of space science, I am pleased to state that NASA is supporting a number of U.S. coinvestigators in ESA's GIOTTO mission to Halley's Comet which will be launched in 1985. NASA is also generously providing assistance in the areas of mission analysis and the modeling of the emphemeris. We are also negotiating with NASA for the services of the Deep Space Network on a reimbursable basis.

I have a few words on remote sensing. The first element on what eventually will be a comprehensive European remote sensing program is ESA's Earthnet program for the acquisition, preprocessing, and the distribution of remote sensing imagery.

The main function of this program is the acquisition of data from Landsat satellites. Here I am pleased to record that the station at Kiruna in the north of Sweden routinely acquires data for NASA from Landsat 3.

The upgrading of the stations at Fucino and Kiruna to enable them to acquire data from the Thematic Mapper on Landsat D is proceeding on schedule. We are most anxious to acquire Thematic Mapper data as soon as possible. To this end, the Agency and the Joint Research Center of the European Economic Community have recently submitted a joint proposal to NASA for participation in the Landsat D image data and analysis program.

In May 1980, operators and potential operators of remote sensing space systems met in Ottawa for a first round of informal multilateral talks with a view to assessing whether, and if so to what extent, compatibility and complementarity between the different systems could be achieved. This exchange is to be followed by a second meeting to be held in Paris in May of this year at which the Agency will be the host.

ESA's plans in the field of ocean remote sensing have been subject to some delay, but we now have approval for an ERS 1 satellite for which I expect detailed phase B studies to start in May or June of this year. This would permit a launch in 1987. This payload comprises a synthetic aperture radar, wind and wave scatterometers, and an altimeter. The spacecraft has the capacity to carry additional instruments, and we have had working level discussions with NASA on the technical feasibility of including a NASA Ocean Color Imager on the satellite. I must say that the ERS 1 program has elicited a great deal of interest in the oceanographic community in the United States.

Although not a cooperative program, I should like to bring you up to date on the development of the European launcher, Ariane.

The third and fourth preoperational flights took place in June and December 1981. Both were successful. As a result, the launcher has been fully qualified. The first operational launch is scheduled for April of this next year after which the launch rate will slowly build up to approximately six per year.

The current launch vehicle is known as Ariane 1. We are now proceeding with the development of Ariane 2 and Ariane 3. The latter will have a 40 percent performance improvement over Ariane 1. These new vehicles will be operational in 1983.

Late last year the member states approved the provision of a second launch pad which will provide faster payload and launch vehicle handling and facility redundancy. A further development, that of Ariane 4, has also been approved. Ariane 4, which will provide double the performance of Ariane 1—approximately 4200 kilograms into a geosynchronous transfer orbit—will have its first flight in 1985.

Although the Agency remains responsible for the development of Ariane and its launch facilities, the operation of the system has now been transferred to the private sector. A private company, Arianespace, has been formed which has assumed responsibility for production, marketing, and launching of Ariane vehicles. This has released the Agency from problems such as prefinancing and other activities for which it is not really suited. ESA has, however, retained political control of launch policy.

In conclusion, Mr. Chairman, I would like to repeat what I said earlier. ESA and its member states remain fully committed to the principle of cooperation with the United States in space activities. We believe, especially in times of financial stringency, that continued international cooperation is essential in carrying out cost-effective programs with limited resources.

Further, I believe that the history of the past 10 years has demonstrated that such cooperation can provide significant mutual benefits to the partners and that my testimony today has indicated that there are and will continue to be similar op-

portunities for the future. It is, therefore, necessary that we, ESA and NASA, urgently consult to improve the modalities of our cooperation so that both sides may enter into future agreements with full confidence.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you very much for your statement. I wonder if you could tell us what the impact of the NASA cancellation of the American satellite for the ISPM has had upon your member nations' willingness to support ESA. Has that caused problems?

Mr. MELLORS. I don't think so, sir. No.

Mr. FLIPPO. Could you tell me the status of the second set of the Spacelab hardware? Is it progressing according to schedule?

Mr. MELLORS. Do you mean the production model? Yes; it is going according to schedule, and it will be delivered on time.

Mr. FLIPPO. Could you tell us about the status of ESA's plans for the Halley's Comet mission and any potential NASA participation?

Mr. MELLORS. As I said, sir, this is going ahead. We are about to let the contract for the phase C/D development. NASA is providing help to the American coinvestigators to our scientists. NASA is providing help with the determination of the ephemeris and the dust hazard. We are, as I said, negotiating with NASA for a reimbursable use of the deep space network during the encounter phase.

Mr. FLIPPO. I see. Mr. Brown?

Mr. BROWN. I am very much interested in your remarks with regard to the coordination of remote sensing and the possibilities for advances in this field and further development of cooperative efforts.

I wonder if you could elaborate on your perception as to the progress that we are making in this area and whether you envision the possibility of a fully coordinated global system sometime in the future?

Mr. MELLORS. I think so, sir. I think that the most likely previous model that one can envisage is something like the Global Atmospheric Research program of the World Meteorological Office where one had five geostationary satellites each developed by different countries and regions and each arranged in a coordinated fashion so that all the results could be used by the whole of the meteorological community throughout the world.

We have, in addition, one of our own programs called Sirio 2 which is going to be used primarily for the relaying of meteorological data between the developing countries in Africa. Each of them have their own meteorological services, but the ground communications between the countries are somewhat sparse. We think that this payload on the Sirio 2 satellite will give considerable help in this direction.

Mr. BROWN. Well, the meteorological field is obviously an example of the value of coordinated remote sensing.

Mr. MELLORS. Yes, indeed.

Mr. BROWN. There is no rational reason for not having all of the nations of the world that need meteorological data utilize the same data collection and perhaps even the same data analysis system. However, we move from meteorology to other aspects of Earth sensing, and the problems get a little stickier in that area.

Mr. MELLORS. Yes, indeed.

Mr. BROWN. I was wondering if you perceived the likelihood of some success in this area. We have, of course, the problem of compatibility of technology in other areas—the computer, communication, and other areas—where it would be beneficial for all the users to develop a common format. We seem to have a great deal of difficulty in doing that.

Mr. MELLORS. Yes. I think that there have already been considerable discussions between NASA and the French Space Agency, CNES, to provide some compatibility between SPOT, the French program, and Landsat D. I think that these discussions have had quite considerable success.

At the moment the Agency does not have a land remote sensing program, largely because of the existence of SPOT. I am afraid, therefore, I am somewhat ignorant on that, but I would be very happy to put the question back to the Director General and let you have the answer in writing, Mr. Chairman.

Mr. BROWN. I am rather interested in your mentioning the fact that Ariane has been turned over to a private company. As you know, we have had some discussions here about turning over certain aspects of the space program to private industry. I don't know whether that will make the problems of coordination between national programs easier or more difficult. Do you have any thoughts about that?

Mr. MELLORS. I am not sure in what sense you are using the word "coordination" there, sir. The reasons I gave for turning it over were, I think, the correct ones. It was difficult for our member states to prefinance construction because really the Agency is an R. & D. agency.

Mr. BROWN. Yes.

Mr. MELLORS. Arianespace has some banks among its shareholders, and this, I think, is probably facilitating their financing arrangements and the arrangements they are able to offer their customers.

As I said, the Agency has retained political control over the launch policy, but, otherwise, we are giving Arianespace a completely free hand.

Mr. BROWN. I am not sure how much political control we will retain when we turn our operations over to private industry.

Thank you very much. I personally appreciate your willingness to appear and keep us apprised of the status of operations in ESA, and I hope we can continue to do that.

Mr. MELLORS. Thank you, sir.

Mr. LOWERY. Thank you, Mr. Chairman. Mr. Mellors, I appreciate your being here. I am delighted to see that Europe is involved in the launching services in a big way and has made quite a commitment to the frontier of space. I think it will be very good for the entire world to see more civilian effort.

I have several questions which are focusing in on the good-spirited competitive situation that I see developing.

What are the costs to an Ariane user versus the costs to a comparable U.S. user? The real question I have is can Ariane successfully compete with the Space Shuttle?

Mr. MELLORS. I think I have to duck that question, Mr. Lowery, because we have now turned over the whole of the marketing and

production of Ariane, as I have said, to Arianespace. Thus, the pricing policy is entirely a matter for them.

Mr. LOWERY. OK.

Mr. MELLORS. But perhaps I should add——

Mr. LOWERY. Can you talk in terms of capability then?

Mr. MELLORS. The capability of the existing Ariane 1 is about 1,750 kilograms into geosynchronous transfer orbit. With Ariane 3 it will be 2400 kilograms into transfer orbit. Ariane 4, which will eventually supersede Ariane 1, 2, and 3, will be a family of vehicles with a capacity at the customer's choice of between 2000 and 4200 kilograms.

Mr. LOWERY. Is there anything more you want to add?

Mr. MELLORS. I was merely going to add that, of course, part of the edge that Ariane is enjoying at the moment seems to be due to the strength of the dollar. With six francs to the dollar and nearly 2.4 deutsche marks, Ariane does come out quite cheaply.

Mr. LOWERY. How soon does ESA plan to develop Ariane vehicles beyond Ariane 4?

Mr. MELLORS. At the moment ESA has no plans. Various of the members states are studying the evolution of Ariane or another vehicle Ariane 5, but as yet we have no firm plans.

Mr. LOWERY. How many U.S. users have deposited earnest money for Ariane launches?

Mr. MELLORS. I think it is five: RCA, Western Union, Southern Pacific, General Telephone and Electronic, and A.T. & T. Western Union, Southern Pacific, and General Telephone and Electronic, have, of course, signed firm contracts.

Mr. LOWERY. When will those launches take place?

Mr. MELLORS. In the period, I think, of between 1983 and 1985.

Mr. LOWERY. If IUS is to be the U.S. upper stage during the eighties with its 5,000-pound capacity to geosynchronous orbit, will Ariane be able to actively compete and to what extent?

Mr. MELLORS. Yes; the performance of the largest Ariane 4 is 4,200 kilograms into synchronous transfer from Kourou which is just about 5,000 pounds in geosynchronous orbit.

Mr. LOWERY. And given the nature and structure of your private company, Arianespace, to what extent do you think Ariane will have a market advantage over U.S. vehicles?

Mr. MELLORS. As I say, I think one of the advantages is the strength of the dollar. A second advantage was that during the development, we deliberately avoided any new technology. It is all existing, quite old technology, perhaps 15 years old. Similarly, we have kept very rigorously to existing and well-known manufacturing techniques so that the production costs have, I think, been kept down.

For example, we used the same fuel and oxidant in both the first and second stages. We used the same engine in the first and second stages, and when we go to Ariane 4, we will use the same fuel oxidant and engines in the strap-on boosters.

Mr. LOWERY. Thank you very much, Mr. Mellors. Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you very much for your testimony. I appreciate it.

Our final witness today, last but certainly not least, is Mr. Willis M. Hawkins, Chairman of the Aerospace Safety Advisory Panel who is accompanied by other members of that panel.

Mr. Hawkins, please introduce your associates and we will, of course, accept your statement in full for the record. Please feel free to summarize as you deem appropriate.

STATEMENT OF WILLIS M. HAWKINS, CHAIRMAN, AEROSPACE SAFETY ADVISORY PANEL; ACCOMPANIED BY RICHARD H. BATTIN, ASSOCIATE DEPARTMENT HEAD, DRAPER LABORATORY, HERBERT E. GRIER, CONSULTANT; AND NORMAN R. PARMET, CONSULTANT

Mr. HAWKINS. Mr. Chairman, I am pleased that these members of the committee could join me today because this is my first appearance before you as the fresh new chairman of the Aerospace Advisory Panel. I am pleased that one of those members of the panel who has joined me is Herb Grier who was the previous chairman.

This is Mr. Herbert Grier, Dick Battin from the draper lab at MIT, and Norm Parmet who is recently from TWA. We will talk about him a little later.

We have submitted to you a summary of what we presented to the Administrator of NASA as our annual report. We have also appended the annual report to our submittal so I think you have all of the details that you would need to explore any particular subject to the depth that the safety advisory panel has penetrated.

I would like to remind you that we were put into being because Congress was concerned about the safety policies and administration at NASA. It is our business to worry about the Administrator's policies, NASA's safety procedural systems, and the hardware concepts in order to maximize as well as we possibly can the highest levels of safety that are possible with these extremely high-risk programs.

The way the ASAP operates is that the whole group tries to attend most of the major program reviews that NASA management has scheduled in order to get the information they get in a normal fashion without intruding upon their operations. We augment that by assigning to various members of the panel special problems so that they and in their own independent way to go into as much detail as they think is necessary. These investigations are reported at our major meetings.

You will find in our written report to you a summary of the members of this panel and the areas of interest and experience for each one of them. These capabilities are the basis for their broad problem assignments.

In addition to reports to the Administrator and his staff we also report to the operating members in the various centers and at the bases in order to suggest improvements that may be too detailed or may need to be incorporated immediately. Many of these do not appear in the normal formal reports.

I want to emphasize that the operation of the Safety Advisory Panel has been completely unrestrained and open down to any level in the NASA organization. The Administrator has insisted

that our access be kept open. Everyone we've dealt with in all of the centers appears to be grateful for our help and has listened to our suggestions.

Last year when we reported to you, we were concerned over preparations for STS 1 and STS 2. This year, of course, STS 1 and STS 2 are behind us. We think that the national shoulder-clapping that has been directed to the whole NASA team is well-deserved. We have been close enough to the details to know that a major miracle of achievement has taken place.

We made our annual report to the Administrator on January 21. He had present with him not only Hans Mark, his deputy, but also the Associate Administrators, Stanley Weiss and General Abrahamson.

We discussed several conclusions with them that I think are worth summarizing for you. First, the space transportation system works. All of the functional concepts appear to be sound and it will do the transport job.

Second, the basic infrastructure, the tracking systems, the communication systems, all of the support at the bases, appears to be in reasonably good shape and has adequately supported the transportation system. It, too, is functionally sound.

The third conclusion is that, with only two flights behind us, the flight data required for the complete development of the Shuttle system up to the limits of its performance envelope, are still meager atbest. Two more flights in the R. & D. program won't expand this body of knowledge very much. Therefore, we must expect that there will be a lot of development that will need to be included with the so-called operational flights scheduled for the near future. This must be done in order to understand the limits to and margins of capability for the Shuttle system.

Our fourth conclusion is that the R. & D. demands of these early flights and the continued necessity for R. & D. results as the operational flights start, has overshadowed the development of operational disciplines. The procedures for a real operation, quick turnaround, routine checkout, all have been subjugated to the R. & D. demands so far. We have urged NASA to put added emphasis on developing these operational procedures.

Our fifth conclusion is that some of the functional elements that are in the space transportation system now are first R. & D. concepts and may not have the capability of achieving safe, quick turnaround. Further operationally oriented development will be required. Thus, these elements will require special attention at each turnaround. They are going to have to be trimmed, monitored, and inspected in much the same way NASA has already demonstrated that it is capable of doing. From a safety standpoint, we don't worry about this process. We do worry that these systems may never, as configured, be capable of quick turnaround Therefore, there may be added development work in the Shuttle in order to achieve the desired flight rate—along with maximum safety. This is an R. & D. task that has to be completed before the Shuttle can be considered to be operational.

We have modified the aerospace safety advisory panel membership, to cover the operational phases. One of our new members, Norm Parmet, is here today. He and another new member, John

McDonald, both have had long histories in the development of new airline transports and the operational creation of systems that make these transports useful to the airlines. We think that they will be able to help a great deal in working with NASA to see that logistics systems ground support gear, and procedures are set up so that safety is not impaired as an operational system evolves.

We think that all of the systems, as I have said, are functionally demonstrated, but we now need to see if there are simplifications that can take place. We have made several detail recommendations to NASA in this vein.

We think they are inconsistent in how backup systems are defined and implemented. There may be some major simplifications that can be accomplished in order to reduce the cost and turnaround time.

We think NASA should look at the use of hypergolic fuels on board the Shuttle. These are not easy materials to handle. They have been the cause of incidents at the Cape. We think that NASA should review the use of the same fuel for its auxiliary systems as they use in the primary propulsion to see if there can be more consistent and safer procedures as a result.

With regard to propulsion and fuels we have asked another new member to join us. He is Gerald Elverum of TRW. He is an expert in propulsion and fuels. He will be joining us as a member very shortly.

We have two very broad recommendations that we think NASA should consider. We think they should seriously consider a separate organization for operating the Shuttle. The obvious focus of such an organization should be the necessity of simplicity, reduced turnaround time, stabilization of changes, and cost, all of which, if done well, will improve safety.

Right now, NASA management is necessarily driven by the R. & D. imperative, but we thinks is is not too soon to try to make operational system changes in both hardware and procedures.

The other broad recommendation is more of a hardware nature. In parallel with the organization and procedures efforts NASA should reassess their application of redundancy. They should look at the total systems they have in the Shuttle to see if they can't simplify them and make them more capable of being operated routinely. After all, the organization that put this transportation system together was a very experienced space organization, but it had hardly ever seen an airplane. Therefore, they have a lot of learning that still needs to be done.

For 1981 our organization intends, of course, to follow Shuttle progress and to keep the pressure on to see that the operational systems and turnaround systems will work. We are specifically going to look at the payload accommodations and particularly those payloads that involve different propulsion systems. Each of these elements has individual hazards, and we will assure ourselves that NASA has controlled them adequately.

There are some performance improvements beginning to be planned for the Shuttle. You heard the Air Force reference to the lightweight boosters and the desirability of their incorporation in the program. The lightweight fuel tank is another improvement

that will be needed. We will review those systems just as we have the basic Shuttle.

A third new area of concern is going to be the emplacement and retrieval of payloads while in orbit. This will involve not only mechanisms that have to be remotely controlled from inside the shuttle but eventually will require crew members operating outside the Shuttle to help with this process and repair or replace parts that have failed. We will certainly concentrate on these new concepts just as we concentrated on them when we thought there might have to be extra vehicular operations to repair tiles.

In addition to the space transportation efforts we are going to reassess NASA's ordinary flying activities. There have been several incidents during this year in which lives have been lost. These have not occurred in carefully controlled test flying activity, but in normal support flying activity. We think the panel should revisit the policies and whether they are being adhered to.

Mr. Chairman, Mr. Grier, Mr. Battin, and Mr. Parmet and I are here to answer questions. I hope that the extent of our work is adequate and I hope you think we are fulfilling our charter.

Mr. FLIPPO. Thank you very much for your testimony. Have you had any feedback from NASA in regard to your recommendations to them such as continuing to gather the R. & D. data after STS 4 and a separate operation organization?

Mr. HAWKINS. I think we will have no trouble at all in getting R. & D. data out of these next immediate flights because they will be under the control of R. & D. people for some time. A separate operational organization, if NASA elects to create it, will take a long time.

NASA, understandably, is having a certain amount of difficulty in trying to figure out how it could separate an operations entity from the organization it has today. I think one of the real problems they have is that they have never been an operational organization; therefore, they are going to have difficulty trying to get out of the R. & D. mode that is more normal for the entire NASA organization.

General Abrahamson is, of course, an operations man as well as an R. & D. man, and I think his assignment has been a step in the right direction. He has been put into a normal organization in the position they hired him for, and I think he is going to help, but I think it is going to take more than that.

We have seen signs at Kennedy, for instance, that they are trying to rearrange their contractual system so that they have fewer contractors and have contractor responsibility over a totally larger system. This means that they are trying to get more management talent from industry into the base at Kennedy. I think that, too, is a step in the right direction.

I know NASA is going to have difficulty trying to handle a totally separated organization. Certainly, it can't be done precipitously because we must have the continuity of the R. & D.

Yes, they are listening to our suggestions: No, they can't find an easy way to do it yet.

Mr. FLIPPO. Are you aware of any unresolved safety issues associated with the Shuttle?

Mr. HAWKINS. No, I think not. I mentioned the one area that concerns us, and that is that there are many subsystems in the Shuttle that are actually obsolete. The Shuttle has been a long time in development, and the state-of-the-art acceleration in the aircraft business has been much more rapid than anybody ever expected it would be. There are, for instance, lots of things that can be learned from our current wide-body transports which could be incorporated into the Shuttle. Making such changes are difficult. NASA, therefore, is going to have to go through a transition phase where they take care of the systems they have with all the care and feeding that will be required. They can do this safely, but they are going to have to make some changes, someday, so that they can cease babying each system as the Shuttle is turned around.

Mr. FLIPPO. Mr. Brown.

Mr. BROWN. As I recall, you made an observation that safety could be enhanced more by the simplification of systems than whatever the comparison was. Is that statement true about the commercial aircraft, the wide-body jets and so forth?

Mr. HAWKINS. No, I think that is the state of the art that has advanced so rapidly. I think the wide-body transports that are in existence today have managed to do this balance between simplicity and redundancy in a very neat way. They have had the help of the airlines. The creators of these transports are used to working with the airlines. I think they have balanced the designs very well.

The Shuttle didn't have that interrelationship between the operations type people and the designers. Therefore, they did some things awkwardly. I think if they review it again they will be able to simplify the Shuttle in several important ways.

NASA may want to increase the redundancy in several places and reduce it in others, either of which would be difficult. All we have asked NASA to do is to assess today's state of the art and take another look at all of the complex systems to see if they can't be simplified.

Norm, would you like to add anything to that?

Mr. PARMET. I just have a casual observation. You mentioned simplicity and redundancy. You take some of the newest airplanes that have only two engines on them, and they are performing tasks that airplanes 15 years ago required 4 engines to do. They are doing it much more effectively, much easier, with lower cost, and with greater reliability. Therefore, I think what I am saying here is backing up what Willis has just said.

Mr. HAWKINS. Do you folks want to add anything?

[No response.]

Mr. BROWN. Let me ask one final question that is completely extraneous to the space program. I notice that Mr. Grier has an extensive background in nuclear test operations. I am wondering if you are aware of any plans to consider that big mess of nuclear test holes out in Nevada as a resource for some future use. One thing that has occurred to me is the disposal of some kinds of nuclear waste.

I guess my question is have there been any studies to your knowledge along this line or what is the situation on that?

Mr. GRIER. Yes, there have. There have been studies and actual drilling activities to determine the permeability of that particular

formation. I guess, as a proponent, I would say it is an ideal place to put waste for the simple reason that there is already waste down there, and we have got to protect the area. As a matter of fact, there are more curies down there than you have laying around to dispose of at the moment.

However, it is just an emotional issue that unless somebody steps up and says, "This is where it will go," it is going to be difficult to solve that problem.

It is perfectly safe from a technical point of view.

Mr. BROWN. Yes. The question is extraneous to the subcommittee, but it is a matter of great interest to other subcommittees in this full committee. I wanted to raise it with you to see what your response was going to be. Thank you very much. I have no further questions.

Mr. HAWKINS. Somewhat facetiously, I would like to say that we don't want the Safety Advisory Panel's responsibilities extended that far. We have got our hands full now. [Laughter.]

Mr. BROWN. Well, I did want to offer this comment, if I might. Having looked at the names and backgrounds of the Safety Advisory Panel, I am going to sleep a lot better at night knowing that you gentlemen are watching over the operations. I think we have an outstanding group of people on the panel.

Mr. HAWKINS. I appreciate that.

Mr. FLIPPO. I would like to associate myself with the remarks of the gentleman from California. I, too, think you are serving a critically important role, and we are deeply grateful for your service and contribution.

Thank you very much for being with us today.

The subcommittee will stand in recess until tomorrow at 10 a.m., in room 2325. Thank you.

[Whereupon, the hearing was adjourned.]

1983 NASA AUTHORIZATION

THURSDAY, FEBRUARY 25, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:09 a.m., in room 2325, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Brown, Hollenbeck, Lowery, and McGrath.

Mr. BROWN. The subcommittee will come to order.

The subcommittee is in the midst of a series of hearings having to do with the program of NASA in order that we may be better able to evaluate the budget proposals of the administration.

Today we are focusing largely, although not necessarily exclusively, on the planetary exploration program and related aspects of NASA's activities. We are fortunate to have a distinguished list of witnesses with us which we have divided into two panels.

The first panel will basically represent the industry which does a good part of the necessary industrial backup on the planetary exploration program. The second panel is more in the nature of scientific participants in the program. We think this will give us a valuable perspective.

Do you have any opening remarks you would like to make? You are ready to work. All right.

I would like to call the first panel, then, which consists of Mr. Walter O. Lowrie, vice president and general manager, space and electronic systems division of Martin Marietta Denver Aerospace; Dr. Albert D. Wheelon, president, space and communications group, and vice president, Hughes Aircraft Co.; and Mr. Robert L. Walquist, vice president and general manager, TRW space and technology group. Can you gentlemen all come up to the table here and we can see how good looking you are.

In the trouble to be with us this morning, I know you have each had to probably travel a considerable distance and spend a little time thinking through some of the aspects of the program. We are looking forward to your contribution. You may proceed in the order that I called your names, if that is all right with you.

93-418 O—82——61

STATEMENT OF WALTER O. LOWRIE, VICE PRESIDENT AND GENERAL MANAGER, SPACE AND ELECTRONICS SYSTEMS DIVISION, MARTIN MARIETTA AEROSPACE

Mr. LOWRIE. Mr. Chairman and members of the committee, it is a pleasure to be here today. I testify about my feelings and our corporate feelings, experiences, and concerns relative to where planetary exploration is going in this country.

I have been involved with the planetary exploration since the midsixties when Martin Marietta became involved in the original Mars exploration program. I am personally very proud to have been the Martin Marietta program director of the Viking program that landed a manmade spacecraft on Mars in 1976.

Mr. Chairman, my prepared text is available for the record. With your permission and in the interest of time, I would like to paraphrase some of it.

Mr. BROWN. Without objection, the full text of your statement will be in the record. You may paraphrase or summarize in any way that you wish.

Mr. LOWRIE. The questions that were addressed to us by Chairman Flippo's letter I would characterize in two contexts: a global set of questions with regard to the impact of planetary on humanity, the world, and the Nation; and a second set aimed at what the planetary impacts are to us in a business sense. I would like to address them in that general order.

First, if I think of planetary in that global context, three things come to mind. The understanding we have gotten of the world we live in—and when I say world, I mean the solar system, the cosmic understanding—this Nation has rewritten its textbooks in the last 20 years. I think that sort of thing is extremely important. The next generation of people will have a far better understanding. Most of the myths about the solar system have been dispelled—many new scientific questions have been raised but most of the myths have been dispelled—and I think that is extremely important. The allied aspect of that is I think the Nation needs outreach kinds of things that drag us mentally and emotionally away from our day-to-day problems. They should not sap our total economic resources and I certainly do not think planetary has done that. Most people in the United States—I know all the people I deal with—have a little bit of Columbus in them. I think the Nation as a people have gotten a vicarious pleasure out of the planetary exploration business. The Viking landings and the recent Voyager encounters had enormous public appeal. It was a little bit of that vicarious pleasure that we were seeing. The planetary program has been a vehicle to help draw the Nation and focus the Nation on a positive beat, instead of the continued focus on negative aspects.

The second major point is in regard to the national prestige. I think the planetary exploration program, because of its visibility, has been a symbol to the world of the technical prowess of the United States. I would like to cite three examples from my Viking experience.

In 1974 I had the interesting experience of briefing a group of Russian newsmen who were brought over here by the State Department. They came to our plant and saw the Viking Lander which

we were in final assembly on at that time. These were newsmen but frankly they were very scientifically oriented newsmen, as you might expect. They were awed by the technical complexity of that beast and were subsequently awed by its performance and the technical implications of what that meant of the capability of the United States.

A second example from the Viking experience came when we landed on Mars, the World Press went bananas for 2 weeks, Iran, London, Tokyo, as well as the U.S. Press. This was of enormous benefit to the United States, again from the portraying of our technical capability to the world. We cannot do that in much of the military work that we, of course, also do very well in this country.

The third example concerns a group that I am sure you are aware of, the international COSPAR group. The meetings back at that point in time for 2 years in a row were absolutely dominated by the United States, largely by Viking, but also the other planetary work that was going on. Over the years they have been dominated by the other programs that these other gentlemen, I am sure, will speak of. That, of course, is talking largely to the science community but also the technical community of the world—not just the major nations, but the smaller nations of the world as well. So, planetary has been a vehicle, in summary, that has given us tremendous prestige throughout the world.

With regard to the question of specific examples of benefits of planetary exploration, this type of question always tends to be the underlying theme; this question tends to ask what is the pragmatic thing it is going to do for me now? I appreciate you gentlemen with your constituents are pressured in that regard in all things that you touch. Unfortunately, planetary cannot do very much in that domain. There are not, in fact, many pragmatic, direct day-to-day results that can be portrayed to the people of the United States.

So, I would tend to say the answer is nothing. On the other hand, clearly all of us can describe spinoffs, many technological spinoffs that have occurred. I mentioned one in my written testimony, the gas chromatograph mass spectrometer on Viking. We packaged a very large ground-based instrument that would fill this table into a small cube. The technology of building the valves and machinery for that device, of course, had an enormous number of spinoffs, as well as the instrument itself. A son of that instrument is being used for poison control measurements in several places in the United States. There are many of these kinds of examples, but the reason I do not want to belabor them is they are not the raison d'etre for planetary exploration, and I do not think we should try to make them so. We can press for them and we probably should but I do not think they are a fundamental driver.

With regard to scientific benefits, I think I had better be humble and let the next panel discuss that in detail, but I guess I would like to make one observation. The useful potential benefits of the science that we will get from better understanding in my view has a very long time constant. We can talk of things like a better understanding of climatology, for example, by studying the atmosphere of Venus and Mars, and a little bit of Jupiter. By modeling them our understanding of the Earth's atmosphere we will improve and clearly will get a better understanding of climatology. The

time for that modeling to produce a useful and pragmatic result is probably very large. It might not even occur in our lifetime. I submit that we should all have a fundamental view that is longer term than that immediate pragmatic aspect. We stand on the shoulders of giants, to use somebody else's quote, who put us where we are and we owe it to the next generations to provide something for them. I think that planetary provides at least one mechanism to do just that.

I would like to quickly now address your second family of questions which are what do we think of planetary as a business? To be blunt, I will give you a schizophrenic answer. On the one hand, the left hand, it is a lousy business. On the right hand, it is a great, enthusiastic, and fun business.

Before I explain this schizophrenic aspect of that answer, let me briefly say, to put it in perspective, that less than 5 percent of Martin Marietta's aerospace business in the last 10 years has been planetary, so I am not here to plunk for planetary from a business point of view. Planetary could go away and Martin Marietta would not suffer in any significant manner from a business point of view; I think the same thing is true for these other gentlemen.

When I say that it is a lousy business, generally it has had poor earnings ratios, at least for us. Maybe my colleagues have been more fortunate. More importantly, because of the instability of the programs, and it has gotten rapidly worse over the last few years, much larger discretionary resources have had to go into the preparation and the bidding of planetary programs. The up-and-down programmatic aspects, that of course have you all worried from a business point of view, are terrible. It soaks up a lot of energy and talent and capability.

On the positive side, and there is a very strong positive side, it is an attractive business. It is stimulating to all the people, me as a manager, previously me as a direct participant, to the company, to the employees. It is attractive—and this is a very significant item—attractive to us in recruiting bright young people out of the colleges. They are turned on. They are enthused in general about an ability to go to work on that type of program. That is vital to us for the future to be able to attract that kind of talent into the industry. I think all of us enjoy the ability to talk openly and frankly to our neighbors and our friends in our community on what our job is and that aspect has also been very good with the program.

From a corporate point of view, the ability to publicize our competence to a broad range of constituents—the community, the media, and the stockholders—is extremely important. In the classified military world, which happens to be most of the other world in our particular company, it is very hard to get that same kind of publicity. Therefore, it is very important to us from that standpoint. So, we are overall supportive and attracted to the planetary work.

I would like to make a couple of brief comments on closing on what perhaps could or should be done, and I am sure you will want to get into that more in the question period. I certainly—and I hope it came through clearly—endorse that some reasonable level of plantary programs should be carried forward by this country. The direction it appears to be heading in 1983 and on is wrong. In

order to do that, we clearly need some enunciated planetary exploration policy to be adopted—and I do not mean a grandiose policy, but something that bounds in and puts a vector on what we as a nation want to accomplish.

I think that some reasonable funding level should be established as a guideline for NASA—and I do not know what kind of restraints could be put on, but the put and take that has been going on in the last few years has got to be stabilized if we are going to have a sensible and stable planetary exploration program.

If we could figure out some way of spiking that level—and incidentally the level that I mentally have in mind is probably on the order of $200 million or something like that annual level in 1982 dollars and not significantly above that. I think the smaller inexpensive, or relatively inexpensive, planetary programs which can still yield a lot of scientific data can move forward at that funding level on some reasonable periodicity which will provide stability to NASA, to the scientific community, to the community of colleges, and so forth, that provide PI's and to the industry.

The industry, in my view, has the least problem because we can move people on to other programs. But that R. & D. scientific and university community out there has the largest problem if you let planetary wither.

I believe the current direction that Noel Hinners and his Solar System Exploration Committee are moving is similar to the above. They are moving in the right direction.

Last, I would like to say that we certainly appreciate the strong support that this committee has provided to the planetary exploration—really over the years—but specifically in the current year in your activities. Government, industry, and science, I think, and the public, have been well served by your actions. Thank you.

[Answers to questions asked of Mr. Lowrie follow:]

ATTACHMENT 2

15 March 1982

Answers to Questions for the Record Submitted to W. O. Lowrie
by House Subcommittee on Space Science and Applications

Question 1: In the hearing, a funding level of about $200 million (in 1982 dollars) was discussed as reasonable for planetary programs. Was this level for development of missions only: Would extra funding be needed for mission operations and data analysis and research and analysis? What might be a reasonable total level?

Answer to Question 1: My discussion of a funding level of approximately $200 million in 1982 dollars referred to the development of missions only. I strongly believe that additional funding for research, data analysis, mission operations, and advanced planning should be added to the amount above. I suggest that a reasonable total for a national planetary program should be about $300 million per year in 1982 dollars.

Question 2: Do you believe (as the NASA budget states) that we are "planning for the systematic exploration of the solar system on a scientifically and technically sound basis"?

Answer to Question 2: Yes. NASA plans are certainly scientifically and technologically sound. The difficulty has been the lack of underlying budget support for a coherent long-range plan. NASA's Solar System Exploration Committee, chaired by Dr. Noel Hinners, will shortly present their recommendations to your subcommittee.

Question 3: From the responses given at the hearing, it might be inferred that you believe a space policy should be developed without a Congressional input, or at least without public hearings. Would you care to comment?

Answer to Question 3: I do not believe a national policy regarding public sponsorship of a long-range exploration of the solar system should be developed without Congressional input. Indeed, both Executive and the Congressional participation will be required along with the scientific and educational communities.

Question 4: Is there synergism between NASA programs and military programs? Could you please give us an example of this synergism?

Answer to Question 4: There definitely is synergism in both directions between NASA and military programs. The most effective example is the use

of people in those industries which have both DoD and NASA work. In terms of technology, silicon solar cell technology has been used both by the military and NASA for many years. In our own company, the Titan launch vehicle developed for military use has been married to the NASA Centaur to launch two Vikings and two Voyagers for NASA and a Helios mission for the Federal Republic of Germany/NASA. These were all planetary missions. The Gemini launch vehicle, a development of the Titan II ICBM, launched twelve Gemini two-man capsules into earth orbit. The military-developed Atlas and Thor have a similar history of usage by NASA. NASA-developed small monopropellant hydrazine rocket engines are used in many military applications.

Question 5: What concerns have you communicated to NASA regarding the effect of the proposed funding cuts?

Answer to Question 5: We have expressed our concerns to all levels of NASA on the cancellation of the Venus Orbiting Imaging Radar (VOIR). Several industrial concerns have invested millions of dollars in the competition for both the spacecraft and the instrument. All of us believed the NASA plan for implementation of the mission would be funded and carried out.

Question 6: How much does rating scientific instruments for manned space flight (on the Shuttle) add to the cost of a mission?

Answer to Question 6: Unless the scientific instrument contains unisolated high-pressure containers and hazardous chemicals, we find no significant cost increments for shuttle flights. The normal engineering analyses and design criteria are entirely appropriate in these cases. In the case of propellants, chemicals and tankage, isolation valves and more conservative proof testing are required, but this cost is small in relation to the instruments total development cost.

Question 7a: Some non-NASA scientists think that the number of NASA personnel used to oversee production of mission hardware is out of balance with the needs of the missions. Would you comment?

Answer to Question 7a: Most NASA equipment is one-of-a-kind developed from a wide technology base for a particular mission. The penalty for failure is extreme. In this light, the motivation for use of NASA personnel to oversee production of mission equipment is understandable. As our industry and NASA expertise matures, I believe this emphasis should and will shift to the industry.

ATTACHMENT 2

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Question 7b: Some non-NASA scientists think that NASA's requirements for documentation of hardware are too extensive. Would you comment?

Answer to Question 7b: We believe that with careful planning, the hardware documentation requirements can be reduced.

Question 8a: If NASA ends their SEPS effort, what will be the outlook for future planetary missions? Are future missions compromised?

Answer to Question 8a: SEPS development can be examined primarily on an economic basis. It has the advantage of some mission velocity flexibility while thrusting at a very low force level for a very long time. In general, a time penalty is paid for trip time. Also, at long distances from the sun, the solar collection area must increase. We have studied no missions in the last few years which require SEPS.

Question 8b: If indeed we are not going to have Centaur, would you suggest using SEPS with IUS for missions to the planets?

Answer to Question 8b: The country will have to have a capable upper stage in the class of Centaur, not withstanding the IUS development. The SEPS development must be compared in costs and mission applicability to more conventional chemical methods for exploring the planets.

Mr. BROWN. Thank you very much, Mr. Lowrie. If there are no objections, I would like to have each of the panelists present their statement first. Then we will question the whole panel as a group.

We expect the chairman of the subcommittee, Mr. Flippo, to return shortly, and I know he would want to have a chance to talk to each of you

STATEMENT OF DR. ALBERT D. WHEELON, SENIOR VICE PRESIDENT, AND GROUP PRESIDENT, HUGHES AIRCRAFT CO.

Dr. WHEELON. Mr. Chairman, my name is Albert Wheelon. I am from the Hughes Aircraft Co. and I guess I am No. 2 on your batter's list.

Mr. BROWN. Well, I read your name second. [Laughter.]

Dr. WHEELON. Mr. Chairman, members of the committee, ladies and gentlemen, it is a great pleasure to be here today. We worked pretty hard on this statement, both in organizing our ideas and choosing our words. With your permission I would like to read it if I may.

Mr. BROWN. Certainly.

Dr. WHEELON. I want to make sure I get it just right. I am pleased to have the opportunity to address this subcommittee and to discuss the status of NASA's planetary exploration program. Few Government programs have enjoyed the success experienced by planetary exploration. Yet the program's future is uncertain. This subcommittee is properly concerned as I understand it and I share that concern.

In considering the planetary program future, we should keep in mind the benefits it has provided this country over the past two

decades. There are three distinct benefits: The first is science return, the second is a sense of adventure, and the third is the national pride and prestige that goes with this activity.

Scientific returns have revolutionized our understanding of the solar system. In two decades, we have visited the Moon, Mercury, Venus, Mars, Jupiter, and Saturn. We will soon encounter Uranus and Neptune. This close-up exploration has greatly increased our knowledge of these planets and the interplanetary environment. Direct in situ measurements have provided a basis for improving and refining our understanding of how the solar system was created and how it may evolve.

Perhaps more significantly, we can now see the Earth from a new perspective. We can compare Earth with our neighbors in the solar system. The important Earth sciences of geology and atmospheric meteorology have profited enormously from what we have learned from the other planets. To cite an example, scientists grappling with the difficult problems of understanding the Earth's global circulation and the characteristics of the Earth's atmosphere have benefited significantly from the results obtained by the recent Pioneer Venus mission. Pioneer Venus has produced valuable data on the Venusian atmosphere and circulation. Over 400 papers have been presented to the scientific community on the subject. Similarities and differences between Earth and Venus weather have been identified. Understanding these similarities and differences allows us to better understand and predict Earth's weather. This planetary synergism is an important product of our planetary program.

The second major dividend of our planetary program is the sense of adventure it provides. The scientific benefits are long range and fully understood by relatively few. The thrill of exploring the unknown is immediate and shared by all. The landings on the Moon, Mars, and Venus, the close-up photographs of Mercury, Mars, Jupiter and Saturn are all memorable events that will become an important part of our Nation's history. In recent years, we have become accustomed to cover stories and television specials describing the encounters of the Pioneer and Voyager spacecraft with Jupiter and Saturn.

Last year, the Nation was able to watch live television transmission of images of the rings of Saturn through the public broadcasting system. These images were transmitted over a distance of almost 1 billion miles, received at stations in Australia, Spain, and California, redistributed through communication satellites stationed at synchronous orbit, and eventually transmitted live into home television receivers all over the world. This event was an unusual example of space technology bringing the adventure of space exploration directly to the citizens of this world.

Though primarily an American endeavor, the planetary program has been shared by the world. It represents a striking example of the accomplishment of this Nation's technology. Our willingness to share results with the world has been a demonstration of our free and open society. Our planetary program has been a symbol of our technological strength. It is a rightful source of our national pride and prestige.

The direct cost of the planetary program has averaged about $250 million a year over the last decade. This represents about 6 percent of NASA's budget. It was about 1 percent of the Nation's research and development expenditures during that time period. The average cost per taxpayer, in case you have not calculated, is about $3 per year. That is equivalent to the cost of a neighborhood movie these days or a six-pack of beer or lunch at a fast-food restaurant. By most standards, the planetary program has not been costly.

The planetary program does not represent a significant source of business for industry as Mr. Lowrie has indicated. Planetary work has averaged less than 6 percent of our space and communication group sales. It has been an even smaller percentage of our earnings, although that is probably our fault. Nevertheless, we are delighted to be part of the program. We built the Surveyor spacecraft for JPL in the sixties, the Pioneer Venus spacecraft for the Ames Research Center in the seventies, and are currently working on the Galileo probe for Ames and JPL. Our people enjoy working on planetary programs. They can share in the adventure of exploration. They can participate vicariously in the scientific discoveries and enjoy it very much. Our people are attracted to these programs in the same way and for the same reasons, that private citizens support the program.

In our Space and Communications Group, the planetary program naturally complements our commercial communication satellite and defense system programs. People and technology transfer both ways. The Pioneer Venus program is a good example. We were able to apply some of our people, procedures and technology from our successful commercial satellite programs to Pioneer Venus and reduce the cost of the Pioneer Venus mission significantly. We believe such technology transfer could benefit future planetary programs.

So much for the good part. Despite its past successes, the planetary program is in serious trouble. The trends and recent events are all negative. There were 38 lunar and planetary launches in the sixties, there were 14 in the seventies, and, with the cancellation of VOIR, there will be 1 in the eighties. In 5 years, there has been no new program successfully initiated. When adjusted for inflation, the proposed fiscal year 1983 planetary budget of $155 million is one-fifth the planetary budget expenditures of 10 years ago and two-thirds the expenditures of 5 years ago.

Accompanying this funding decline are a vacillation and uncertainty of purpose that are seriously undermining the program. The problem has been compounded by doubtful decisions made in regard to launch vehicles required for planetary missions.

The Galileo program is a good example. Originally scheduled for launch in 1982, Galileo will now be launched in 1985, God willing. The upper stage planned for Galileo has changed three times in the last year. In 1980, NASA decided to separate the probe and orbiter and launch them separately on the IUS. A simple probe carrier was thus needed for the probe mission. In December 1980, NASA announced that Hughes had won a competition to build the probe carrier. In January 1981, NASA announced it would recombine the mission and cancel the probe carrier procurement. The

costs saved by canceling the probe carrier would help underwrite the development of a new Centaur stage for the Shuttle. However, the Centaur plans were recently canceled. Galileo will now be launched on an IUS two-stage. The mission is to be recombined; it will just take 2½ years longer to get to Jupiter.

There are other examples similar to the Galileo history. The International Solar Polar Mission [ISPM] was canceled soon after it began full-scale development. SEPS—solar electric propulsion system—has been started and stopped several times over the last few years. After years of study and debate, we have passed up the unique opportunity of exploring the comet Halley in 1985.

The most recent example of vacillation is the VOIR program. The program was eliminated from the fiscal year 1983 budget after several years of program definition and competition, after substantial company resource investments by JPL and four major aerospace companies, after the VOIR was established in the fiscal year 1982 budget, after teams had been formed, after all plans were laid out and full-scale development about to start.

This vacillation is wasteful. It undermines the basic science objectives of the program. For example, the fiscal year 1983 budget proposes terminating the scientifically prolific Pioneer Venus orbit data-taking mission in order to save $7.5 million, while adding $20 million to Galileo to accommodate programmatic growth and changes, basically the change of the upper stage vehicle. Several productive planetary missions could be created from the waste that has resulted from the recent erratic course NASA has followed in regard to planetary spacecraft and their associated launch vehicles.

This approach to the planetary program has been inefficient, discouraging to the participants, and threatening to the future. This problem—the lack of a steady course—is fundamental and it transcends the fiscal year 1983 budget problem. If the situation continues, the institution supporting the planetary program will dissolve. For Hughes, the loss of business would be inconsequential. We would focus on DOD and commercial programs. If necessary, we could reconstitute our planetary spacecraft capability later on by drawing upon our DOD and commercial communication satellite capabilities. However, once dismantled, the NASA, JPL and scientific community institutions would be very hard to reconstruct. Considering the value we have received from the planetary program and its relative small cost, I do not believe we should dismantle our program. Rather, I think we should be establishing a policy that gives the program a direction which is consistent with today's budget limitations.

The fundamental problem, in my view, is that NASA planetary missions have been expanding while the budget has been shrinking. Past successes have probably fueled the notion that each succeeding mission should be even more spectacular. Adventure has been emphasized relative to science. Consider some of the more recent proposals: The Galileo orbiter and probe is now a $900 million mission; the VOIR mission which would image all of Venus to high resolution is about a $700 million mission; rendezvousing with a comet which requires the development of a solar electric propulsion stage is over $1 billion; and a Galileo-like orbiter of Saturn

with two probes, one for Titan and one for Saturn itself, is about a $1 billion mission.

These missions are complex and expensive. The more expensive the mission, the harder it is to sell. Hence, bells and whistles must be added to improve its salability, and of necessity, its costs. New starts grow more expensive and less frequent.

Each year, we experience a ritual in which NASA and the science community assault the administration and Congress to sell the latest proposal. Their advocacy is familiar to this subcommittee. Their lack of success is equally apparent. It is a fact that our planetary institutions are more focused on selling than producing results, more oriented toward short-term expedient moves than sound long-term planning.

Mr. Chairman, I believe we need a national policy for our planetary program. We need a framework—agreed to by all parties—within which NASA and the science community can plan a sound program responsibly. Then our institutions can focus on performing rather than promoting.

We believe a healthy and vigorous planetary program can be comfortably included in NASA's current budget allocations. We believe that there are many missions with modest cost that can sustain the science, adventure and prestige benefits that this country has enjoyed in the past. To illustrate my point, let me cite a few examples of missions we have studied over the last several years:

A Delta launched Halley intercept mission with cometary imaging and other science. Total mission cost, in 1982 dollars, about $100 million, exclusive of launch vehicle costs.

A series of atmospheric programs to the outer planet bodies with atmospheres; namely, Saturn, Titan, Uranus, Neptune. Total mission cost less than $50 million a year if properly paced.

A Mars orbiter focused on understanding the Mars climate and the evolution of water on that planet. Total mission cost about $100 million.

A simplified Venus mapping mission with 1 kilometer resolution. Total mission cost $250 million.

The common bases of these missions are extensive use of existing designs developed on other programs and scaled back, but still meaningful objectives. I'm convinced there are other potential programs which would produce good science at relatively modest cost. The Solar System Exploration Committee under the direction of Dr. Noel Hinners has identified a number of such missions. This group has provided a good framework for evaluating future low-cost missions.

I suggest that the administration and Congress define an acceptable level of spending for the planetary program and then allow the NASA and the science community to implement a series of modest missions. A planetary program budget of $150 million to $250 million per year—about 4 percent of NASA's overall budget—would be adequate to sustain the type of low-cost missions I've described. It would be consistent with the current environment of budgetary restraint. It would allow us to continue our productive planetary program. The science community would be able to continue the exploration of the solar system. The Nation could continue to enjoy the adventure of exploration. Having received clear di-

rection, NASA would be able to proceed in an efficient manner to fulfill its mission. Industry would benefit from a more stable program and could contribute its technology developed from the DoD and commercial market. Eventually, if budget permits, more ambitious missions could be superimposed upon this solid base of planetary exploration.

Mr. Chairman, I believe it is within our power to reverse the decline of the planetary program. I believe it is feasible to establish a meaningful program within the current budgetary constraints. I believe a policy of a relatively constant budget in the $150 million to $250 million range with modest missions could achieve that objective. I think you will find that industry and the science community would support such a program.

I thank you for this opportunity to express my viewpoint.

[Answers to questions asked of Dr. Wheelon follow:]

QUESTION 1: In the hearing, a funding level of about $200 million (in 1982 dollars) was discussed as reasonable for planetary programs. Was this level for development of missions only: Would extra funding be needed for mission operations and data analysis and research and analysis? What might be a reasonable total level?

ANSWER: The annual budget for mission operations and data analysis and research and analysis has been running at approximately $100M per year. We believe it is reasonable to project continuing at that level in the future. An additional budget of $100M per year for mission development would bring the total planetary exploration budget to $200M. This would allow $1 billion for mission development over a period of ten years. The missions we have discussed range from $100M to $300M, or an average of approximately $200M. Hence, a total of five planetary missions could be developed in ten years. This is considerably better than the one mission currently projected.

A preliminary Solar System Exploration Committee (SSEC) report proposes a systematic exploration of the solar system at an annual level of funding averaging $350 to $400M per year. This would produce 15 missions over ten year's time. This more ambitious program would be desirable if NASA could afford it. We conclude a program in the range of $200M (3% of NASA's budget) to $400M (7% of NASA's budget) would be reasonable.

We believe a cohesive plan of planetary exploration should be formulated, a corresponding budget level should be determined, and that NASA and the science community should be left to intelligently implement the program within the allocated budget. NASA should be allowed flexibility to replan the program in order to stay within their allocated budget. We believe a sound and productive planetary program would result at a relatively modest cost.

QUESTION 2: Do you believe (as the NASA budget states) that we are "planning" for the systematic exploration of the solar system on a scientifically and technical sound basis?"

ANSWER: There is one planetary exploration mission planned for this decade. To us, this does not appear to be a systematic exploration of the solar system.

QUESTION 3: From the responses given at the hearing, it might be inferred that you believe a space policy should be developed without a Congressional input, or at least without public hearings. Would you care to comment?

ANSWER: We believe Congress should play an important role in the development of a space policy for planetary exploration. In fact, the planetary exploration program could benefit from Congressional leadership. Our point was that Congress should limit itself to policy and refrain from interfering with the detailed management of the program.

QUESTION 4: Is there synergism between NASA programs and military programs? Could you please give us an example of this synergism?

ANSWER: There is significant synergism within NASA programs, military programs, and commercial programs in the Hughes Space and Communications Group. A common technical staff supports all three product lines. Hence, technical expertise is transferred between programs. Devices developed for one program can frequently be modified at relatively minor cost for another program. Our Pioneer Venus spacecraft, for example, utilized hardware that had been originally developed for defense satellites and communications satellites. This synergism is why we believe planetary programs can be accomplished at a relatively low cost by use of parallel developments in the DoD in the commercial sector.

QUESTION 5: What concerns have you communicated to NASA regarding the effect of the proposed funding cuts?

ANSWER: We have expressed concern about the waste resulting from frequently changing plans in the planetary program. We committed substantial resources to competing for and winning the Galileo Probe Carrier in late 1980. In January, 1981, NASA announced that the program was cancelled. We committed substantial resource to competing for and winning the VOIR SAR program. That program has been cancelled. The Galileo Probe program has been stretched out three years from the original schedule, with consequent cost growth.

These changes have cost a substantial amount of money. They have wasted valuable time of key engineering talent. The resources of money and engineering talent are limited and should not be needlessly expended.

QUESTION 6: How much does rating scientific instruments for manned space flight (on the Shuttle) add to the cost of a mission?

ANSWER: Our experience is that instruments flying on the Shuttle costs approximately the same as those flying on free-flying spacecraft.

QUESTION 7a: Some non-NASA scientists think that the number of NASA personnel used to oversee production of mission hardware is out of balance with the needs of the missions. Would you comment?

ANSWER: Our most recent experience with NASA's management of a planetary program was Pioneer Venus. This program was managed by the Ames Research Center. We estimate that their management cost was less than 4% of the overall program cost. We do not believe that this level of management was out of balance with the needs of the Pioneer Venus mission.

QUESTION 7b: Some non-NASA scientists think that NASA's requirements for documentation of hardware are too extensive. Would you comment?

ANSWER: We do not believe that the NASA Ames Research Center requirements for documentation of hardware was too extensive on the Pioneer Venus Program.

QUESTION 8a: If NASA ends their SEPS effort, what will be the outlook for future planetary missions? Are future missions compromised?

ANSWER: Most of the missions proposed by the SSEC do not require the use of SEPS. Hence, if NASA ends the SEPS effort, there still could be a meaningful program of exploration. Those missions that require SEPS, e.g., Comet rendezvous, would have to await the development of SEPS or a comparable stage. In our estimation, a high energy upper stage (such as the recently cancelled wide-body Centaur) is more important to the planetary program than a SEPS. We propose that the development of such a stage should precede SEPS development.

QUESTION 8b: If indeed we are not going to have Centaur, would you suggest using SEPS with IUS for missions to the planets?

ANSWER: SEPS will be a relatively expensive development. Its use in conjunction with the two-stage IUS will be rather limited for planetary exploration. We recommend that money available for stage development is best spent for a high energy upper stage. A SEPS development would be a logical following step.

Mr. FLIPPO. Doctor, thank you very much for your testimony.

I would like to welcome Mr. Walquist, the vice president and general manager of TRW Space and Technology Group. We are very pleased to have you with us.

STATEMENT OF ROBERT L. WALQUIST, VICE PRESIDENT AND GENERAL MANAGER, SPACE & TECHNOLOGY GROUP, TRW ELECTRONICS AND DEFENSE

Mr. WALQUIST. Mr. Chairman and members of the Subcommittee on Space Science and Applications.

First of all, I appreciate the opportunity to present testimony here today on what I perceive to be the impacts to this Nation of significant reductions—or even possible elimination—of our interplanetary exploration program. A great deal of what I am going to say has already been said by the two gentlemen, one on each side of me. Some of that I will be covering has a somewhat different perspective than they may have presented.

In looking at the value of the interplanetary space program I would like to focus on three areas: The history of the program and spin-off benefits that have accrued to us from that program; the value of interplanetary exploration in relation to our technological preeminence in the world and the benefits of that preeminence; and, third, the future implications of decisions that are being made today.

First, the history of the U.S. planetary and interplanetary space program is one of spectacular events, particularly during the decade of the 1970's, and was a visible demonstration of the technological excellence of this Nation. The program has generated much new scientific data, increased by orders of magnitudes man's understanding of the solar system, and clearly established the uniqueness of the third planet from the Sun—our own Earth.

In the decade of the 1970's, this country explored the atmosphere of Venus and examined the planet Mercury. We landed on the planet Mars and—much to the disappointment of many—found no Martians and no water in its canals. The 1970's also brought us the first spectacular pictures of Jupiter, its giant red spot and its moons—and the first closeup pictures of Saturn, its rings and its many strange and varied moons.

Importantly, these spectacular accomplishments of the 1970's were the result of commitments made in the 1960's—the decade of the great U.S./U.S.S.R. space race, and demonstrate the long lead time necessary for planning, building, launching, and voyaging to these various encounters.

It is appropriate that we talk about our interplanetary exploration program at this time because next week we will celebrate the 10th anniversary of a spacecraft that exemplifies the exciting achievements of our interplanetary space program.

On March 3, 1972, 10 years ago, Pioneer 10 lifted off from Cape Canaveral on the start of its long and successful space exploration voyage. In July 1972, it began a 7-month journey through the asteroid belt, a band of rock, dust, and debris that had been considered a barrier to interplanetary space travel; Pioneer 10 showed that spacecraft can traverse the belt without damage.

In December 1973, Pioneer 10 passed within 82,000 miles of Jupiter, and returned to Earth more than 500 spectacular photogaphic images of the planet and its four moons. It transmitted the first closeup data about Jupiter's environment and measured its intense radiation belts.

Jupiter's gravity hurled Pioneer at 81,000 miles per hour on a trajectory that will send it out of our solar system. Passing the orbit of Uranus in July 1979, Pioneer 10 by 1983 will be further from the Sun than any known planet as it probes for the edge of the solar system and crosses into the boundary of interstellar space—the first man-made object to leave the solar system.

Today, 10 years into the mission, Pioneer is still communicating with Earth—on an 8-watt transmitter from its cold and lonely location over 2.5 billion miles from Earth. Radio signals from Pioneer 10 take more than 3½ hours to reach Earth.

Pioneer 10—and its sister ship, Pioneer 11, which supplied the first exciting closeup pictures of Saturn, its rings and moons a few years later—have significantly enlarged scientific understanding of those giant outer planets and have provided data that scientists hope will shed new light on the early history of the Sun and the origin of its planets.

The spinoff benefits from the space exploration program have been many. However, I agree with Mr. Lowrie that the benefits of the program should not be judged too strongly only on the basis of technology spinoff. But let me highlight some of those spinoffs. They may be less obvious than the Earth resources and communications satellites from the space applications program, so let me highlight just a few here today. From the zero leakage, low pressure, highly reliable valves used on the Mars Viking spacecraft, NASA, and the Rochester General Hospital have developed a human implant prosthetic urinary sphincter system, a development that probably would not have been achievable without those valves.

From the same Viking spacecraft, the optical profilometer developed for the spacecraft camera system led to a device being used in Florida to improve the care and treatment of infants born with abnormalities of the head and face.

The technology that has gone into the computer enhancement of photographs from our planetary probes, has been put to work sharpening the images from human X-rays, and from ultra-sound probes which examine blood flow and diagnose arterial blockages.

The design technology required to make interplanetary spacecraft autonomous and immune to communications outages of significant length can be adapted and is being adapted to military communications satellites which have a critical need to be survivable and to endure during possible ground station outages in times of emergency.

The more generic—but equally important—disciplines of quality and reliability have been demonstrated nowhere else better than in our interplanetary space program. Pioneer 10—2.5 billion miles away—still communicating after 10 years.

As for technological preeminence, for two decades America has profited from its position of preeminence in space exploration both in international stature and in national pride.

There is no question that planetary space events are spectacular and provide a very visible demonstration of the technological excellence of the country that performs them. Worldwide exposure to these spectacular events has led to universal recognition of the U.S. capability for monumental technical tasks. With this awareness comes respect and more likely acceptance of U.S. roles in international affairs. I cannot help but believe that our world leadership and ability to negotiate at international conferences is directly related to our image of technological superiority, as perceived from the other side of the table.

Looking inward, another benefit to us from our outstandingly successful interplanetary program is national pride. Let us not underestimate this factor. The excitement of space exploration is widely disseminated by the press and the television. The American people are justly proud of this national capability and support the cultural changes associated with a more sophisticated society. This same awareness and pride have motivated many of our young people to enter careers in science and engineering and to accept the technical challenges of the next generation.

I am often asked the question "Why do you bother with NASA business when all of those large defense contracts are available?" Well, NASA business is extremely important to me. It may not have the monetary value of defense contracts but it is always technologically significant work and is synergistic with much of our defense work. This high technology work provides stimulus and motivation to my engineering and scientific personnel. It provides an attractive arena to encourage new, highly educated college graduates to seek employment, thus helping me keep a good mix of young, as well as experienced, scientific and engineering personnel. Since NASA programs are generally on the cutting edge of technology and have a content that tends to capture the imagination of the public, they provide us with an excellent advertising medium that can be openly disclosed. Such open disclosure is seldom possible for defense programs.

As for the future, the actions which may result from the discussions we are having today will assuredly decide what interplanetary activities this country will participate in during the 1990's. Yes, the long view is necessary both to maintain the important momentum we have built in interplanetary exploration and to determine our role 10 years from now. It can not be taken lightly.

The only new major planetary program for the 1990's is Galileo's journey to Jupiter. If we add the Voyager encounters with Uranus and Neptune, which will occur in the second half of this decade, and the continued operations of Pioneers 10 and 11 and the Pioneer Venus orbiter, we have the totality of the U.S. interplanetary programs for the 1980's.

We must continue a balanced program of space exploration. Astrophysics programs such as the Gamma Ray Observatory, the Space Telescope, the Advanced X-ray Astrophysics Facility, and the Solar Optical Telescope will continue to extend our search of the universe from the vantage point of an Earth orbit. All have benefits and will capture the imagination of the public and the minds of young people. All will help us maintain our technological momentus.

Likewise, planetary and interplanetary programs have a similar role of exploration and expansion of our knowledge here on Earth. We must continue these programs. Understandably we have limitations of the scope of programs that we can afford and we must select them carefully, but we need to plan a sustained program.

In the corporate world, we look at return on investment as an important criterion for planning new ventures and committing funds. Past performance in the area is often key. For the last decade the planetary and interplanetary budgets have been only about 6 percent of the total NASA budget. I believe the country has achieved a very good return for this investment. Our track record is outstanding and our confidence should be high that we can continue this kind of performance.

We have made an important investment over the past two decades to achieve our present preeminence in space exploration. With the judicious selection of programs, the cost to maintain this leadership should not be prohibitive. If we lose this leadership, however, along with all of the benefits which accrue to the winners, the game of catchup will be incredibly expensive.

Thank you.

[Answers to questions asked of Mr. Walquist follow:]

R. L. Walquist
30 March 1982

RESPONSE TO QUESTIONS

Q1. In the hearing, a funding level of about $200 million (in 1982 dollars) was discussed as reasonable for planetary programs. Was this level for development of missions only: Would extra funding be needed for mission operations and data analysis and research and analysis? What might be a reasonable total level?

A1. As I stated to Congressman Brown during the question and answer session after the testimony presentation on 25 February, I am not in favor of establishing a definite budget dollar value for a planetary exploration program and then define the program that fits the dollar constraints. I believe that key members of the government/industry team should jointly establish a reasonable policy to be followed for the next 10 to 15 years and then we should see what budget is required to support it.

Q2. Do you believe (as the NASA budget states) that we are "planning for the systematic exploration of the solar system on a scientifically and technically sound basis"?

A2. Fundamentally, yes. The NASA Solar System Exploration Committee, under Noel Hinners, has been developing a plan that is technically and scientifically sound. If the United States implements that plan, we will have a reasonable program for systematic exploration of the solar system.

Q3. From the responses given at the hearing, it might be inferred that you believe a space policy should be developed without a Congressional input, or at least without public hearings. Would you care to comment?

A3. I believe that a National Space Policy should be developed from the broadest possible base of relevant inputs within some reasonable time constraint. Clearly, joint Congressional, NASA, DOD and Industry inputs are vital to such a policy.

Q4. Is there synergism between NASA programs and military programs? Could you please give us an example of this synergism?

A4. Yes, there is synergism. As I mentioned in my testimony, the design technology required to make interplanetary spacecraft autonomous and immune to communications outages of significant length can be adapted to military satellites which have a critical need to be survivable and to endure during possible ground station outages in times of emergency.

Q5. What concerns have you communicated to NASA regarding the effect of the proposed funding cuts?

A5. In September of 1981, I prepared a paper entitled "The Harm of Not Doing Civilian Space Research'. This paper has been widely distributed and discussed with top NASA officials in Headquarters, Marshall Space Flight Center, Lewis Research Center and Johnson Space Center.

Q6. How much does rating scientific instruments for manned space flight (on the Shuttle) add to the cost of a mission?

A6. If the instruments are developed initially for flight on Shuttle, then the incremental cost due to the manned space flight requirements are relatively small. These requirements are primarily due to Safety Requirements delineated in NHB 1700.7 which require additional efforts in documenting and testing of materials used in construction and added design constraints when dealing with hazardous materials.

Q7. (a) Some non-NASA scientists think that the number of NASA personnel used to oversee production of mission hardware is out of balance with the needs of the missions. Would you comment?

(b) Some non-NASA scientists think that NASA's requirements for documentation of hardware are too extensive. Would you comment?

A7. (a) The question of need for numbers of NASA personnel is really a judgement call that should be based on the quality of the NASA personnel and the need for high quality, state-of-the-art hardware from the contractor. On the specific NASA programs with which I have been involved, the numbers of government personnel have not appeared excessive.

A7. (b) For people that have been used to providing space qualified hardware to the government, NASA documentation requirements are not overly extensive. However, their objective to further streamline and simplify the requirements for Shuttle payloads does seem to have been abandoned.

Q8. (a) If NASA ends their SEPS effort, what will be the outlook for future planetary missions? Are future missions compromised?

(b) If indeed we are not going to have Centaur, would you suggest using SEPS with IUS for missions to the planets?

A8. (a) Some, but not all missions will be compromised. It is to the advantage of the United States to develop the SEPS capability in order to accommodate some missions requiring high velocity changes (comet and asteroid rendezvous) that address fundamental questions on the origin of our solar system and galaxy. SEPS offers greater flexibility and efficiency in the design of these missions.

(b) This is only one of many good alternatives which couple a high energy stage (SEPS) with a conventional high thrust chemical stage (IUS) for long distance space missions. Besides such combined stages, another alternative is the development of integral propulsion stages for each mission. The relative commonality of needs and the corresponding costs need to be considered when evaluating which of these various options should be pursued.

Mr. FLIPPO. Thank you very much for your testimony.

Mr. Brown.

Mr. BROWN. Mr. Chairman, I want to first indicate how significant I think this testimony is coming from the very distinguished gentlemen representing three of the major aerospace and affiliated firms in the country. I note that Mr. Walquist has also provided us with very glossy publications here that emphasize some of the points that he made, particularly budgetary impact. I would like to ask the chairman to have this made a part of our record, also.

Mr. FLIPPO. Without objection, so ordered.

[Material follows:]

THE POTENTIAL FOR HARM IN REDUCED SUPPORT OF CIVILIAN SPACE RESEARCH

R.L. Walquist,
Vice President, TRW Inc.

September 1961

979

THE POTENTIAL FOR HARM IN REDUCED SUPPORT OF CIVILIAN SPACE RESEARCH

R.L. Walquist, Vice President, TRW Inc.

We at TRW applaud the general intent and aggressive mechanization of the President's economic recovery program. In his letter to the President on April 27, R.F. Mettler, chairman of the board and chief executive officer of TRW, pledged full support of the program in all its aspects. I feel that part of that support is to call attention to the unfortunate potential of protracted reductions in federal support of U.S. space technology. Continued reduction in these activities for the next several years will harm America's economic posi-

tion and further erode our nation's prestige in the world.

The deferral or cancellation of many major space science missions is by default a policy to withdraw support from U.S. space-related technological growth. It is important that the consequences of this policy be weighed carefully before world leadership is abdicated. According to Dr. George Keyworth, the President's science and technology adviser-designate,

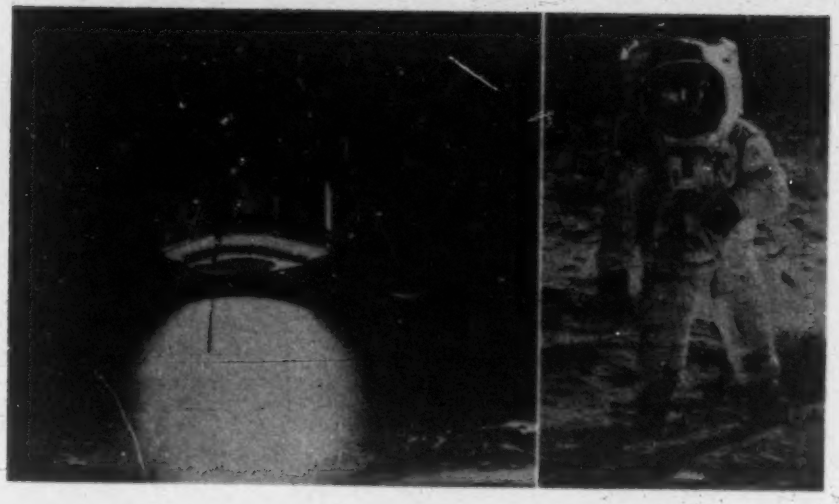
> ***There are certain projects . . . where the government's support continues throughout research, development and demonstration because of the broader national interest at stake.***

The important choice facing the nation now is to recognize which projects in space research entail this broader national interest. Unless we are willing openly to abandon specific goals in national prestige and economic advantage, we should exercise great care before we diminish the federal support of civilian space technology.

The importance of science and technology to the economy is an accepted fact of our modern society. But the past several years have seen a significant and continuing reduction in the funding devoted to advancing our non-military capability in space. Even our military budgets have stressed operations over new technology. It is clear that in time this trend will erode our technological position in the world.

In contrast to the approach taken by the United States, the Russians and Japanese have developed a consistent long range policy to advance their capabilities in space. The activity in Europe has also been increasing steadily over the past decade. The non-military elements of these programs include materials processing, communications and earth applications (resources and weather).

For two decades the United States has profited from its position as pre-eminent in space exploration and space research. The worldwide exposure to the manned lunar landings, to the close encounters with other planets, and to the further under-



standing of our sun and the earth have facilitated a universal recognition of the U.S. capability for monumental technical tasks. With awareness of American pre-eminence comes more likely acceptance of U.S. roles in global affairs. Withdrawal from leadership in space exploration is to invite erosion of this acceptance and respect.

The excitment associated with scientific exploration is widely disseminated by the press and television. The American people are proud of this national capability and support the cultural changes associated with a more sophisticated society. This same awareness and pride have motivated many of our young people to enter technical careers and accept the technical challenges of the next generation.

The scientific exploration of space is driven by man's inherent curiosity to increase his understanding of the universe. In testimony before a congressional subcommittee, author James Michener aptly described this drive and its importance:

> ***We risk great peril if we kill off this spirit of adventure, for we cannot predict how and in what***

seemingly unrelated fields it will manifest itself. A nation which loses its forward thrust is in danger, and one of the most effective ways to retain that thrust is to keep exploring possibilities. The sense of exploration is intimately bound up with human resolve, and for a nation to believe that it is still committed to forward motion is to ensure its continuance.

Other nations will continue their investigations and pursue opportunities that would normally be associated with United States expertise. The Russians, for example, are planning missions in astrophysics, using the Venera series of spacecraft. They are also planning a mission to analyze Halley's comet. Clearly if Russia is perceived as the scientific leader in the community of nations, U.S. prestige will suffer.

The USSR manned space flight now totals 132 percent of that of the U.S. The USSR plans to have a permanent space station manned continuously with engineers and scientists. We project that they will achieve this before mid-1982. On the basis of this projection, the USSR's manned space flight will be 167 percent of that of the U.S. by the end of 1984, assuming the United States maintains the present STS schedule.

The lack of United States technological achievements will cause a declining competitive capability for United States industry and products. The decline will be felt in aerospace and in the industries that have benefited from the associated technologies. As Americans perceive a loss of American scientific leadership, we risk the loss of pride in our national capabilty. And it is certainly predictable that America's youth will be less inclined to enter scientifically-oriented careers.

The ability to sense and transmit vast amounts of data from extremely remote places with very high reliability represents one significant contribution that investments in space science and technology have made to United States industry. The list of contributions is very large and so broad in its effects that it is likely to be taken for granted.

Mr. BROWN. I would like to focus on just a couple of areas which I think may be significant. First, recognizing that the space program is more than just a planetary program but the space science applications is very important also. Of course the space transportation system is highly significant, absorbing most of the money right now. I would like to focus on some indicators of the economic and commercial implications of the space program.

Perhaps I could ask specifically with regard to communications satellites you gentlemen are all familiar with and engaged in, in some cases, building. How large a commercial market, globally, is there?

Dr. WHEELON. I could probably answer that question, Mr. Brown.

This year the sales of commercial communications satellites will probably be $300 million. That figure will go in a very few years to almost a billion dollars per year.

Mr. BROWN. Per year?

Dr. WHEELON. Per year.

Mr. BROWN. Does Hughes have a good piece of that market?

Dr. WHEELON. A fair share, but not all of it. [Laughter.]

Mr. BROWN. Whatever the share is you think it should be more.

Do you think it is important to the economic future of this country, and possibly the national security, that we should continue to maintain preeminence in this kind of market—I don't say necessarily just the communications satellites but generally speaking the commercial market represented by spinoff from the space program?

Dr. WHEELON. I do.

Mr. BROWN. Do the rest of you gentlemen agree with him?

Mr. WALQUIST. Yes, sir.

Mr. BROWN. And I would assume, and this of course is a leading question, that one of the necessary ingredients in maintaining that leadership is to have a substantial number of leading firms engaged at the cutting edge of this and have our best, some of our best scientists, technologists, motivated to remain in various aspects in this space program?

Mr. WALQUIST. Yes.

Mr. BROWN. We would elaborate the economic significance of, and the contribution that the planetary programs makes to these combined goals, but I don't want to try and make more out of that than is actually there.

Another thing that I wanted to focus on, however, is alluded to or hinted at in your statement that the need is for a reasonably foreseeable regular program. Each of you, I think, has entered that fluctuations in the planetary exploration program are not conducive to maintaining the kinds of supportive, industrial or scientific bases needed. You suggest the possibility that a program in the neighborhood and not much more than what we are doing now, but within a framework on which could be counted upon as dependable would be an improvement. Is that correct, Mr. Walquist?

Dr. WHEELON. Yes.

Mr. WALQUIST. Mr. Brown, I would like to make a comment on that.

First of all, I did not, and very carefully so, did not specify a dollar budget which I felt was appropriate for the interplanetary

program, and my reason for not doing that is I have some concern with what's been happening. We talk about budgets, and more importantly the budget fluctuations, which have been, in my judgment, by default establishing a fluctuating interplanetary policy rather than policy establishing the budget levels; and to me the appropriate way to go about this is to come out with a policy, what it is we believe is important to achieve on a long-term basis in the interplanetary program and then have a budget which supports that.

The problem that NASA is facing and, Mr. Brown, you mentioned that the space transportation system has been absorbing most of the NASA money so that the nonshuttle expenditures are a small fraction of the total NASA budget. The problem NASA, in my judgment, is facing is exactly similar to what Cal Tech faced many years ago when JPL was an integral part of Cal Tech, and the JPL budget was considered along with the total operating budget of running that university. Due to the overall magnitude of the JPL budget compared to the rest of the Cal Tech budget 10- to 20-percent fluctuations in that total operating budget would wipe out the institute but it would leave JPL intact, and I believe NASA is facing those types of considerations today in their budget deliberations.

Thank you.

Mr. BROWN. We appreciate that comment.

Would it be a more reasonable way to approach our planetary budget if we were to do as you suggested, say, build on the report that will forthcoming later this year, and to develop on the basis of that report a long-term, say a 10-year or longer, 20-year, policy framework for planetary exploration and cooperation between NASA and the industrial firms that might have a contribution to make at the academies or universities. Would we be in a better position if we could establish such a policy base and then try and carry that out?

Mr. LOWRIE. Exactly. I think we are all saying the same thing in perhaps a slightly different way. That's what I was trying to say and maybe it was presumptive for me, maybe presumptive for Bud to quote a dollar value, that dollar value really should follow the natural evolution of policy in a framework.

I was giving you an opinion of what the budget level will fall at if the kind of policy that the Solar System Exploratory Committee is headed toward emerges as a final recommendation.

Dr. WHEELON. Let me add a word to that.

I guess I was being presumptive, but I thought pretty hard before I presumed. About 4 years ago I made a talk—with some of your colleagues, actually, on a panel—in which I advocated a systematic reconnaissance of the solar system before the end of this century at a fixed level which would be set and agreed upon between the administration and the Congress, which would not rise because of overruns, which would then accommodate the best job we could do within that limit.

Having made that kind of a generalized statement, I felt it incumbent upon myself to suggest what that limit might be and still admit a significant science, so it was only to set a lower limit and

one that really is about where we are now if we just do it right. So that was the extent of my comment.

Mr. BROWN. I think, Dr. Wheelon, you commented that the best program in real dollars is only about a fifth of what it was 10 years ago.

Dr. WHEELON. Yes.

Mr. BROWN. I think there are some members of the committee, and I hope in Congress, who would support a program that, say, might be half of what it was 10 years ago or some reasonable figure, but that is the matter that should be determined in a long-term policy.

Let me comment that we really do not have a long-term space policy at the present time encompassing all of the features of the space program; that we haven't had really a major policy framework since we made a manned lunar landing a top priority goal for this country; that we have been moving in a rather sporadic way since then looking for goals and without a consistent policy framework. Am I correct?

Mr. WALQUIST. Yes, sir, that was sort of my message, and I think that was Dr. Wheelon's message in terms of the Galileo program, the International Solar Polar Mission, an internationally established mission between us and the Europeans. We withdrew the U.S. spacecraft, because of budget considerations, and caused some rather difficult international relationships for a while. Yet, the U.S. Government had signed a memorandum of agreement with the Europeans to go ahead with that, and Galileo has faced this similar type of on-again/off-again fluctuation.

Mr. BROWN. Lacking a coherent, long-term space policy, almost any specific project can be attacked on the basis that it isn't as important as feeding the poor or maintaining a new atomic submarine or something of that sort, who is in competition.

Thank you.

Mr. FLIPPO. Thank you.

Mr. McGrath.

Mr. MCGRATH. Thank you, Mr. Chairman, and may I congratulate the panel for a most enlightening presentation.

First, I would perhaps like to give you the benefit of an experience I had. Just last Friday I went home to speak to a group, a community group, a wealthy area, well educated, and all women, and one of the questions I received was "Don't you think we should stop wasting our money on space exploration; get down to some of the more tangible things in order to feed the poor, as Mr. Brown said, or whatever?"I think we have done fairly bad job in projecting what the benefits of planetary exploration program and scientific transfer programs are about in the past, and the thing if we are going to expect some place in the future to be able to continue the type of funding that we all feel is necessary for these particular programs then we better do a better job in telling the American people what the benefits of the program are.

Having said that, I am interested in the concept of coming up with a fixed dollar, perhaps not fixed but a dollar amount so that we can continue a planetary exploration program. And I kind of use the analogy of when we were having the fluctuations in defense budgets in the past, perhaps the more recent past, and while

the major contractors stayed in business with some of those fluctuations some of the suppliers did not, and as a result when more money was available for that particular purpose they couldn't gear up fast enough, suppliers couldn't gear up fast enough to spend the amount of money that was available. So I'm interested in that particular aspect, and more recently I understand that a press conference was held at NASA, the subject was the scientific community was pushing a small budget, cheaper budget. Dr. Wheelon mentioned a few of the projects that could be done on a smaller budget basis. I want to know how true this is and, No. 2, to what extent have you proposed this to NASA and the administration. What have you done in order to communicate this?

Dr. WHEELON. Well, that is my question, I think.

The question is, What is the reality of the cheap missions? Are they really going to be cheap or is that just the going in position?

There is a fair amount of evidence that you can look at. You can look at what it costs and what is regularly charged and delivered in the commercial market. We regularly develop and deliver communications satellites for on the average of $30 million apiece, and like 24 different ones. So do other companies. And those satellites are in general of the complexity that we are talking about here. So I think that it is not a conjectural thing, it is a matter of record what this kind of equipment should cost if suitably defined at a low enough level. The additional cost, I think, comes about because of, one, adding a great many features to these programs and, two, the program starts and stops.

For the Halley Comet mission we did actively propose a program of that sort to the last administration and to NASA. It was rejected as not being ambitious enough, and I don't quarrel with that, but the fact is that we were prepared to do the job essentially on a firm basis for the dollars I mentioned, namely, under $100 million. So I think that there is a real belief on our part that we can do low cost, modest, but still significant missions, for these kinds of dollars.

Mr. MCGRATH. Let me make just one very brief observation. The testimony of Dr. Wheelon mentioned fluctuation back and forth between Centaur and IUS—I think that yesterday, maybe a couple days before maybe there could be one less fluctuation.

Mr. LOWRIE. I might add, if I might to Bud's comment on this matter, his words went by my ears and I did not hear anything that shocked me. We have studied many of the same kinds of things, not all them, and I agree wholeheartedly with his comment. It does require a couple of ingredients: Stability, program stability and a stabilized science appetite. You can't come and add goodies in the middle of a program and then run the kind of program costs that he is talking. If you do those two things you can produce those kinds of costs of these kinds of missions.

Mr. MCGRATH. There was a significant experiment done within NASA, it was called Pioneer Venus. It was a two spacecraft program, four probes. Do you know about the program, launched in 1978?

Mr. WHEELON. Four probes were launched into the atmosphere of Venus. One spacecraft went into orbit around Venus. It is still operating in orbit around Venus, except it is going to be cut off. That

program was done—the two spacecraft and their probes were built for just about exactly $100 million in then-year dollars. Now, that would be inflated up to about $200 million today. That program was begun and operated as an experiment and low-cost planetary program. It was pretty acultural and it ran into a lot of problems. Jim Fletcher and George Lowe began that program with—and Hans Mark, who was then the director of the Ames Research Center—with a fierce determination to apply the techniques and the practices that we had in commercial communications satellites to see if we could build planetary spacecraft similar to them. And, frankly, it went pretty well, it went pretty well. There was one small problem, and that is like hide-and-surprise something, you know where the musicians get up and leave one by one and pretty soon the audience is there all alone. Well, if you think all of the key drivers in this program, they all disappeared one by one, and we were left with people who really didn't associate too strongly with the original objective. Notwithstanding that, the fact is that I think that it was a pretty good show for not very much money.

Thank you.

Mr. FLIPPO. Thank you, and, gentlemen, I think that it is important to point out that I totally agree with you that the Nation does not have a very well defined, or certainly a not very well understood space policy. I might point out that that is also true in energy. We don't have a long-range or short-range energy policy; we don't have a very well understood military policy or any of these other kinds of policies—just to put this one in a little bit of context, not to say that it is our ability of—it wouldn't be very nice.

You know, we could have a policy that was spelled out and that policy could be changed, as you have certainly pointed out that previously—the up and down instability part of it. We had agreements and policies on the development of the Shuttle. Those kind of agreements were changed. I am wondering what kind of signals could we give, you know, if Dr. Hinners comes in with a report and Dr. Keyworth comes up with a national space policy. Will just the fact that we have an announced policy make the contractor community and the scientific community any more comfortable? Is there some specific act perhaps, such as the development of some type of transportation vehicle for the planetary program? Is there any kind of single step that would convince our people that we are going to be in the planetary business for the long run?

Mr. WALQUIST. May I make a first try at that, Mr. Flippo?

The thing that I would look for coming out of that policy was the general aspects of the plan for meeting that policy that was agreed to by Congress, NASA, and the White House, that established what it was that we were going to do in the interplanetary program over the next 10 on 15 years; and had the interrelationships of those programs, the basic timeframe, and where the emphasis going to be placed. Will it be placed in several of these relatively inexpensive approaches to planetary exploration such as Dr. Wheelon has suggested, will it be placed in a few but perhaps more exotic attempts at looking at things within our planetary system. Clearly that type of a plan, if it had some stabilty to it, even though it might get shifted downstream under certain budget constraints now and

then, would be a desirable starting point. The difficulty that we have seen over the last several years is that type of plan not only has shifted downstream on budget constraints, but programs that were approved had been canceled, programs that weren't approved had been brought in, and programs that were approved to do certain missions had been torn apart, like Galileo, and then put back together again as the budget cycled. And I believe that is fairly dilatorious to any type of planning that you would like to do and any type of maintenance of personnel, either within the Government or within industry.

Dr. WHEELON. I have a comment on that.

I think that there is a model for the kind of a program I was advocating within the NASA budget; it is called the explorer program. It doesn't get much attention from Congress or from the press or from industry. The level of funding is more or less fixed. They go along and do the thing they can within that level and they do pretty good science. It is a good program, and it is like more or less for the people who are good at doing it.

I think that when we inflate these missions into great big deals they, of necessity, attract great public debate. They also generate congressional interest, fascination and debate. Congress engages in the type of jousting contest that we have experienced with the Galileo mission.

I submit that approach is not in keeping with the climate or the resources that we have today. I think we could have a planetary explorer program with Congress deciding the level of funding and letting NASA run the program. If I may be a little impertinent I think Congress is part of the problem. I think that the excitement of the debate, of the jousting contest, about these missions has become part of the problem. I think if we could all—industrial people, Congress and OMB—back away a little from how the details of the program ought to be done and confine ourselves more to what is the appropriate goal of the program and what is the appropriate funding level, I think that people could operate within those constraints in a very intelligent and responsible way on behalf of the country.

I hope that isn't impertinent.

Mr. FLIPPO. An honest opinion is not considered impertinent in this committee.

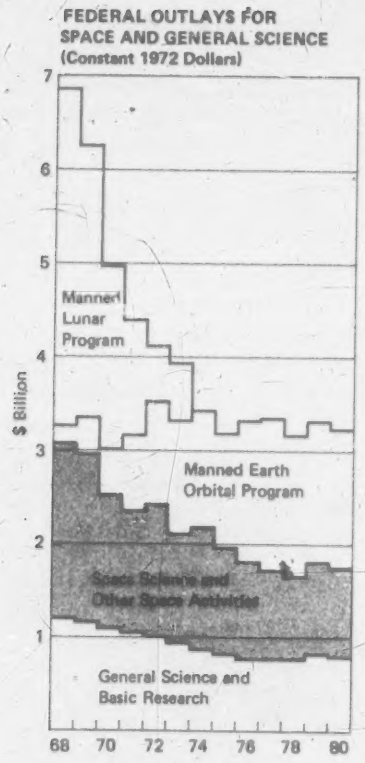
Mr. BROWN. Shocking but not impertinent. [Laughter.]

Mr. FLIPPO. Each of you has indicated some serious concerns about reduction in the civilian program. Do you think the 1958 Space Act is relevant today? Do you think we could gain anything from our public debate on space policy by way of congressional hearings, extensive congressional hearings?

Dr. WHEELON. You should want to think about that very carefully.

A lot of institutions that we have today, like NATO, could probably not be re-created today in the present environment. I would go at that pretty carefully.

Mr. FLIPPO. Now, each of you have indicated some concern about the potential for a loss of U.S. preeminence in foreign competition. Could you give us some examples of that loss or what—I believe


FEDERAL OUTLAYS FOR
SPACE AND GENERAL SCIENCE
(Constant 1972 Dollars)
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7
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Orbital Program
Space Science and
Other Space Activities
General Science and
Basic Research
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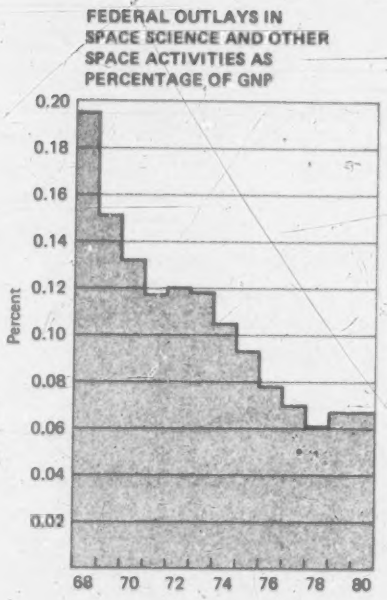
FEDERAL OUTLAYS IN
SPACE SCIENCE AND OTHER
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PERCENTAGE OF GNP
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80

Walking pattern of crippled child is measured and recorded without the inhibiting tangle of wires through a spin-off of space telemetry. Step sensors in soles of shoes and miniature radio transmitters send signals to receiver without wires.

These toll-booths, at the Evergreen Point Bridge near Seattle, Washington, have air purifiers whose design profited from NASA "Clean Room" airflow technology. The booth's airflow system retards infiltration of contaminated air and decreases the toll-collectors inhalation of engine exhaust fumes.

Largely as the consequences of space research the U.S. has led the world in computer technology, resource development, metallurgy, microelectronic devices, and health sciences, as well as communications. These contributions not only facilitate national growth through product proliferation but provide an edge to American industry when competing in international markets.

Pioneering in other areas of space research with potential commercial benefits is just beginning, notably in the area of materials processing in the microgravity of earth orbit. The commercial potential in this area, suggested by the products in the accompanying table, is very large. With 60 experiments on materials solidification and crystal growth on Salyut 6, the USSR is already pacing the U.S. by a significant margin.

Private industry cannot risk the extremely large, long-term development costs characteristic of advances in space applications. To do so, even for the largest of companies, is to risk corporate collapse. Corporate managers charged with a public trust simply cannot accept such a possibility. To maintain the U.S. at the leading edge of this tech-

POTENTIAL PRODUCTS FROM PROCESSING IN SPACE

PRODUCT CLASSES	PRODUCT EXAMPLES
PHARMACEUTICALS:	ANTIHEMOPHILIS FACTOR VIII, ERYTHROPOIETIN, PANCREATIC BETA CELLS, AND LATEX SPHERES
ELECTRONIC DEVICES:	SEMICONDUCTOR MATERIALS, DETECTOR MATERIALS, X-RAY TARGETS, AND SOLAR CELLS
OPTICAL PRODUCTS:	LENSES, LASERS, FIBER OPTICS, ELECTRONIC SUBSTRATES, UNIQUE GLASSES AND NARROW BAND FILTERS
ADVANCED ALLOYS:	TURBINE BLADES, SUPERCONDUCTIVE MATERIALS, MAGNETIC MATERIALS, CORROSION-RESISTANT ALLOYS, NUCLEAR FUEL RODS, AND LUBRICANTS

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nology, federal funding of the advances in the technology through flight demonstration is necessary.

In sum, it appears highly desirable that the United States examine carefully the long-term effects on the nation of its trends in space research. Clearly we are allowing our position of international pre-eminence in this area to be eroded. We face the likelihood that Russia will become the apparent world leader in space exploration and applications. We also face the loss of the dramatic technological fallout in products and skills that has been shown to follow space research. To help reverse these trends, flight demonstrations in space research and applications are necessary. Because the risk capital for these ventures is much too high for private industry, support must be provided by the federal government.

you mentioned that, Mr. Walquist, in the brochure. Do you have any examples of that?

Mr. WALQUIST. There are some areas, and let me relate to a particular program, and I believe that Dr. Wheelon mentioned the particular program.

The United States had an opportunity to undertake a Halley Comet encounter and we passed that by. The Europeans are going ahead with that particular mission. We had the opportunity to jointly participate in an International Solar Polar Mission where there were to be two spacecraft with both of them taking experimental data, but data of different types and attempting to do some cross-correlation between information picked up in one portion of the space around the Sun that is out of the plane of the ecliptic and cross-correlate that with what the other spacecraft was finding in a different area. With the withdrawal of the U.S. spacecraft the activity will now be conducted by the Europeans without our participation.

In the commercial arena there has been a significant amount of development in both Japan and in Europe of components and technology addressed toward communications satellites, both for the current term and for the long term, different frequencies than we have been working in for the future and different capabilities. One example is high level traveling wave tube which radiate on the order of several hundreds of watts of power. The purpose of those developments is to go into direct television broadcasting into the home. So those are a few specifics where the technology within the European and the Japanese areas is moving ahead of us.

I believe in the majority of the space area we still carry a significant lead in our technology development, and the question is do we wish to fall behind in additional areas.

Dr. WHEELON. Can I elaborate on that?

Mr. FLIPPO. Certainly.

Dr. WHEELON. I can speak about what it is like in the commercial world because I live there a lot of the time.

The Europeans made a determined policy decision a number of years ago, almost 10, to do two things. One is to become independent of our launch vehicle capability, to build Ariane so they could get into space when they wanted to on their own terms; the second is to emphasize what they call application programs, and read that as commercial communications satellites. They have made the investments, and they are now appearing on the world markets, and they are formidable competitors I can tell you. We competed against them, we, the Americans, in Australia. We won that round about 3 months ago, but it was tough competition. Their technology is good, not quite as good as ours, but good enough. They combine that with aggressive financing through their Export-Import Banks, which we are unable to match these days, and significant diplomatic pressure, and they are very, very hard to beat. There is a competition about to be decided in Brazil for a domestic satellite system. There are no American competitors. It is the Canadians versus the French because there is a combination of aggressive financing and offset requirements that no American company is able to match, and we cannot compete with a sovereign government.

There are competitions coming up in both Colombia and Mexico. The competition includes significant European elements. I don't know how those will come out. I would remind you the Arab League was won by a French concern, Aerospatial. More importantly, European launch vehicles are capturing a significant share of American communication satellite launches. Westar 6 will be launched on an Ariane. Southern Pacific and G.T. & E. have recently elected to use the Ariane instead of an American launch vehicle.

So our loss of preeminence in space is already with us. Some of it is probably a good thing, but the international competition is coming on strong.

Mr. FLIPPO. But excluding the Soviet Union, the rest of the world is spending less than $2 billion a year on their space programs, which is less than a third of what the NASA budget is. And I am just curious to know what—we must not be using ours as effectively, I suppose.

Mr. WALQUIST. Well, Mr. Flippo, I believe Mr. Brown earlier mentioned, at least let me read into what he said that the space transportation system is absorbing most of the NASA money, and I agree with that statement. As Dr. Wheelon mentioned, the Europeans are concentrating on a low-cost booster and they are concentrating in the applications area. So if you were to compare the $2 billion that the rest of the free world is spending you ought to try to factor out what is going into the Shuttle, which is a means to get large payloads into low Earth orbit, not to get them into synchronous or any orbit above about 150 miles, and compare the amount of funding that the United States is putting into those types of related activities versus what the rest of the free world is. I believe you would find that the balance would shift in the other direction.

Mr. FLIPPO. Mr. Hollenbeck.

Mr. HOLLENBECK. Thank you, Mr. Chairman.

Going back a little bit to the area that Mr. McGrath was touching; namely, cheap missions and later the subject of Halley's came up, and the VOIR mission. Now, NASA, as we know and as we have discussed, is not proposing a Halley's mission; however, other countries are going to undertake that. I am assuming that we will have access to the scientific information that they gather. But will that information be of the same nature and relevance and information that we may have sought out or gathered?

Dr. WHEELON. Since I raised the subject, perhaps I ought to try to answer that.

Mr. HOLLENBECK. May I also say I want to deflect some of your remarks over to OMB.

[Laughter.]

Dr. WHEELON. Well, first of all, there are a number of missions being planned to go to Halley. I know very little about what the Russians plan to do. I know quite a bit about what the Europeans plan to do. It is a scientifically modest mission, but still a meaningful one and an important one. It is comparable to the low-cost version that we have proposed. JPL had proposed a more ambitious and a more capable mission, and I think that would have been a big improvement. For a variety of reasons OMB and NASA decided

they could not advocate that more ambitious, or in fact any mission, and so I think we simply let them go by default.

Mr. HOLLENBECK. On that topic of the VOIR, there are many people who had hoped that understanding or trying to reach an understanding of the atmosphere on Venus may help us in terms of comprehending our own possible greenhouse phenomenon or greenhouse effect, so called. Now, NASA plans to fly a mapping mission, Venus mapping mission instead of the VOIR. Will this provide us, in your opinion, with the same type data or nearly the same type data that we might ever see from VOIR.

Mr. LOWRIE. No, the VOIR mission, in addition to doing a radar mapping, had added some other science. That additional science is not in the current forecast of the so-called mapper. It is being reverted to a mapping mission solely. You get no real atmospheric information of any kind. The science community believes the resolution we are going to with the Venus mapper will still give a very meaningful scientific mission, but within that framework we have a mapping mission only.

Mr. HOLLENBECK. Just to be crystal clear, the objective of both VOIR and the Venus mapper is to make topographic maps of the surface of Venus, not to study its atmosphere?

Mr. LOWRIE. Venus Mapper is topographic only. The added science on VOIR did address atmospheric questions also.

Mr. HOLLENBECK. The like question is how accurate is it supposed to be.

Mr. LOWRIE. The Venus Mapper is planned to retain the VOIR low resolution to map most of the planet. The VOIR high resolution mode intended to map a small fraction of the planet is planned to be dropped. Under, again I guess the discussed subject of Galileo and IUS—apparently there is an excellent chance of a 2-year slippage, or additional 2-year trip time for Galileo by using the IUS. In reality—the financial aspect of it——

Mr. HOLLENBECK. Aside from that, will this affect—the additional 2-year trip time—affect the scientific objectives of the mission? Will there be minuses or possibly pluses ultimately, or will the result be the same?

Dr. WHEELON. If I may, I think that question better goes to the next panel who understands the scientific objectives better than we. Probably the only thing that we can respond to is the reliability aspects of the additional 2 years of trip time involved. To a first approximation, there is no significant spacecraft reliability degradation. We are building the probe for that mission, the one that will go into the atmosphere in a parachute, and our judgment is we can do just as well with a 2-year longer trip time, but I am really not fully aware of what the scientific issues are.

Mr. HOLLENBECK. Thank you.

Mr. FLIPPO. Thank you very much for your testimony.

I think, for the record, that we should state that I agree, Doctor, that Congress has probably contributed to the problem. [Laughter.]

Mr. FLIPPO. I might point out that this committee and the Congress has always funded NASA to the extent of the NASA request and that this committee in particular has inserted funding for ISPM and those many other projects. There are some of us who feel that the real problem with the space program has been be-

cause it has not enjoyed the significant attention of previous administration's Chief Executives, Presidents, in the past; and not just this one, but many others who haven't decided how they want to utilize the great expertise. I would hope and I am sure other members would join with me in hoping that you gentlemen would take advantage of every opportunity to express to the executive department the real need for that.

Thank you very much for your testimony.

Dr. WHEELON. Just one postscript. I didn't have this committee in mind when I talked about the Congress. [Laughter.]

Mr. FLIPPO. We now welcome Dr. Eugene H. Levy, chairman, Committee on Planetary and Lunar Exploration, Department of Planetary Science of the University of Arizona; Dr. David Morrison, Institute for Astronomy, University of Hawaii; and Dr. Werner Suomi, Space Science and Engineering Center, University of Wisconsin, Madison.

Gentlemen, we are indeed delighted to have you. We will accept your statements in total for the record, and please feel free to summarize, and proceed as you deem appropriate.

You may start, Dr. Levy, if you would like.

Dr. LEVY. Dr. Morrison is on first.

STATEMENT OF DR. DAVID MORRISON, PROFESSOR OF ASTRONOMY, UNIVERSITY OF HAWAII

Dr. MORRISON. Mr. Chairman, members of the subcommittee, I appreciate the opportunity to be here. I testified on behalf of the NASA budget last year before this committee, and it is a privilege to be back again to discuss the particular issue of the planetary program.

The United States has enjoyed international leadership in planetary exploration for 20 years, sending probes of increasing sophistication throughout the solar system and vastly enriching our knowledge of our own planet and its place in the cosmos.

These voyages of science and exploration have gained for our Nation worldwide respect and admiration, at the same time stimulating our high-technology industry, and, perhaps most important, inspiring a whole generation of our young people with a promise for the future.

In view of this successful program, I find it remarkable that I am here today facing what is the collapse of the program of planetary exploration. As you know, there have been no new launches since 1978, there have been no new starts since 1978, and the Galileo mission is the only mission we now expect to have a planetary encounter during the 1990's other than the Voyager continuations and that is not until the end of the nineties.

In addition, planetary exploration has received a steadily shrinking fraction of the NASA budget. With the budget now proposed for fiscal 1983, the process of slow fiscal strangulation is being replaced with a precipitous decline, a decline that I think can only be described as a going out of business budget for planetary exploration.

I will pull no punches: the proposed budget is a disaster for planetary science and exploration, and I wish to argue the necessity of

substantial restorations if we are to maintain the base level necessary to continue that program and perhaps in the future to carry out more ambitious efforts.

Members of the previous panel have emphasized the possibilities for low-cost missions, for developing a strong program along the lines of the Solar System Exploration Committee. I think those are very constructive comments, but my concern right now is the proposed budget for fiscal 1983 is so bad that it will destroy the base that is necessary to be maintained if we are to establish that kind of program of missions in the future.

There has been talk from NASA officials and others that we can somehow put off planetary exploration. Terms have been used such as mothballing facilities or deferring programs, but I would emphasize that you can't mothball or defer the people whose special dedication and knowledge make the planetary capability a reality. Many of these people are already leaving the field, and if the fiscal 1983 budget is enacted as proposed, I think we are going to be losing many hundreds of critically talented persons who will not be easily brought back into this program in the future.

I don't need to tell this committee how popular the program has been. I think one of the strengths of planetary exploration is that although it represents only a little more than 3 percent of the NASA budget, it in fact is a high-visibility program which we can be proud of and which gains us international prestige.

One example that came to mind, I note that there have been six cover stories on Time and Newsweek in the last 2 years dealing with the space program, three of them with the Shuttle, but three with the planetary exploration program. It is a highly cost-effective part of the NASA program.

Let me move on now to discuss trends in the NASA planetary budget. During the 1960's and the first half of the seventies, NASA supported a vigorous program of planetary exploration, with seven new starts in the interval from fiscal 1966 through fiscal 1972. During the 10 years from 1966 through 1975, the average budget for lunar and planetary exploration, not including Apollo, was approximately $600 million a year in current fiscal 1983 dollars, and had a maximum in fiscal 1984 of about $800 million.

Since that time the program has declined steadily, averaging only about $250 million in current year dollars during the last 5 years, and now, with the fiscal 1983 budget, dropping to $155 million. The fiscal 1983 proposed amount is only one-fifth of the peak year funding of 10 years ago, and less than 40 percent of the average value over the 17 years since fiscal 1966.

At a time when we are all aware of the growth of Federal Government, I think it is important to recognize that we are dealing with a program that has shrunk steadily and precipitously in the last few years.

Now, the areas that are most severely impacted in the 1983 proposed budget are mission operations and research and data analysis. The one major flight program under development, Galileo, continues, which is of course an excellent thing, but the funds in other areas amount to a shortfall of $40 million. That $40 million compares to simply continuing the base program from the fiscal 1981 level. It involves no new initiatives.

In my statement I describe some of these specific impacts of such a cut, and I would like to summarize those briefly. I would emphasize the $40 million I am talking about is only the amount required to maintain current level. In the long run we must initiate new missions. I am simply not going to address that now, because I think the other needs are more imperative.

I would also like to say that I have no argument with the way NASA managers have chosen to implement this $40 million cut, painful though the individual cuts may be. The problem is the policy that dictated such a low ceiling for the total planetary budget.

Let me enumerate, then, some of the areas that will be cut under the fiscal 1983 budget. First, the Pioneer Venus Orbiter, which is successfully continuing in an extended mission, which is probing new regions of space around Venus as the orbit evolves, and which is planned now for operation through 1992 when it re-enters the atmosphere.

The current fiscal 1983 plan would be to terminate data transmission from this mission completely. Second, the Pioneers 10 and 11, which were discussed by the previous panel, are the spacecraft that are farthest from the Sun; they have 10 years of trip time, and they have the prospect of exploring regions of the solar system we have never been to before, and in particular passing through the heliopause and getting the true interplanetary space. Again, in order to save a relatively small amount of money, the fiscal 1983 budget proposes turning these spacecraft off. And I emphasize my understanding is you actually send a radio signal to them telling them to turn off their receiver so they can never get another signal from you again.

The third element I mention is the lunar territorial facility and Houston completed that not long ago, and the repository for our entire—almost entire collection of lunar samples and the means through which those samples are made available to the scientific community for analysis, the samples will be kept under plans being conidered by NASA. The availability of those samples and the continued analysis of them would dry up almost completely.

I also mention the infrared telescope, the IRTF, on Mauna Kea, which was completed by NASA with NASA funds just 2 years ago, and which is the most sensitive infrared telescope in the world, making major contributions through ground-based studies to the support of NASA missions, and is supplying data which we cannot get from spacecraft, data that I would say are particularly important for spanning this data gap that we inevitably will have during the next decade. The plan is to close down that facility also.

The Mars data analysis program, which was developed to allow proper utilization and analysis of the tremendous fund of data obtained from the Vikings at Mars, is to be another casualty of the fiscal 1983 budget. The Viking Orbiters in particular had a much longer lifetime than was anticipated, and late in the mission were brought into lower orbit so that they could map the surface of Mars with extremely high resolution. Many of the pictures and other data from the Titan mission have almost been unused. There has been no opportunity to do analysis on them, and this budget would terminate that work right in midstream. . .

The data analysis from the Voyager missions is also slated for a major cutback, again not permitting us to make the logical use of data that we have acquired at great expense from missions that were extremely successful, and again cutting off the flow of new information that is necessary to keep a vital scientific community at work.

Cutbacks are also planned in studies of Comet Halley, and in fact in many other areas. Just enumerating the most visible of these areas does not really give a concept of the scope of the impact of these cuts, because they go across the board. I was discussing at NASA Headquarters with people yesterday that one is talking about RIFing of the order of 500 trained scientists, students and technicians, from this program due to cuts that are being felt in virtually every area of research and analysis.

Let me very briefly touch upon the value of the program, and I would be happy to go into this in more detail in questions, but I would like to mention two areas that are of particular interest to me. One is the fact of the potential use of space resources, resources from the Moon and resources from the asteroids. It is an area that we do not yet know the practical significance of, but we will not know that if we don't at least initiate surveys through spacecraft of the asteroids and of the Moon that will let us determine the potential economic value. There have been many arguments that there are materials there that are accessible, that can be obtained, and we need to go out and make sure.

I would also like to mention a field of growing interest, which is the effect of the impacts on the earth of asteroids and comets. We know these impacts have taken place in the past, things like the meteor crater in Arizona, and a recent example. There is increasing evidence that 65 million years ago it was the impact of a 10-kilometer asteroid on the Earth that led to such catastrophic effects as the extinction of more than half the species on Earth, including the dinosaurs. We have hardly begun to investigate the populations of the nearest asteroids and meteorites to determine the potential danger from such impacts. I would like to mention especially one danger that could be due to even a rather small impact, and that is a small impact by astronomical standards is still big by hydrogen bomb standards. I have often wondered what the response of the defense systems of either the United States or the Soviet Union would be to an unexpected impact of nuclear dimensions coming at the wrong place at the wrong time. It could certainly trigger the possibility of worldwide nuclear war.

There are of course less tangible benefits in high technology that have been discussed by the previous panel. I would like, though, to mention finally the very important areas of national pride and international prestige that derive from all of our civil space program. At a time when the Nation is beset by problems both internal and external, I think it is particularly important that we undertake visible, challenging tasks and carry them out successfully. All Americans were thrilled by the success of the Shuttle, but the planetary program also contributes substantially in this area. And it does so in a highly cost-effective way. I believe that it is imperative that we continue a renewed commitment to space exploration to provide world leadership in this important area. Again, the imme-

diate problem, it seems to me, is to maintain the base in this difficult fiscal 1983 year so that we will be able to expand the program if we wish to do so in the future.

Thank you, Mr. Chairman.

Mr. FLIPPO. Thank you very much, Dr. Morrison.

STATEMENT OF DR. WERNER SUOMI, SPACE SCIENCE & ENGINEERING CENTER, UNIVERSITY OF WISCONSIN—MADISON

Dr. SUOMI. Thank you, Mr. Chairman, other members of the committee, for allowing me to testify on behalf of NASA's planetary program. As you have heard, others have stated, and will state, very good basic science, and we have heard business reasons for continuing our highly successful planetary exploration program.

I wish to add to the testimony in two areas. First, the Earth is a planet, too. And I want to tell you about the possible benefits of a better understanding of the mechanisms of the Earth's climate that could arise from a strong and continued planetary program.

Second, I want to emphasize the need for a vigorous research effort now that we have an enormous body of new data and information on all the planets. First, climate and weather are not the same thing. Weather is a condition of temperature, humidity, cloud cover, rain, snow or pressure at a particular place at a particular time. It is really too bad that there was not a roaring storm over Washington this morning, because then you might listen more carefully to my testimony.

The planetary programs are not likely to contribute much to improved weather forecasts on Earth. However, the planetary program is very likely to help us understand the average property of the weather over an extended time period of seasons or years, which is what we mean by the term climate.

We already have a good theory for the Earth's weather behavior, particularly for large-scale storms, and our daily forecasts make good use of this theory. Climate variations are also very important in our complex society, maybe even more important than the weather. Despite their importance, our ability to predict the climate is not good. We know that climate variations happen, but we don't understand why they happen. There have been dramatic variations in the last few years. This winter has been called the coldest for this century, and in Europe too. But winter is not over, and we will have to wait and see if that is really true. The 1980 summer heat wave severely affected our agricultural output.

Earlier there was devastating drought in the Sahel, and we could go on and on with specific examples. In a recent issue of Science, two Illinois scientists tested the Farmer's Almanac. In a limited 5-year record, it was a trivial amount better than just flipping a coin. According to the article, even NOAA's attempts to predict climate were only 10 percentage better than one gets on a 50–50 coin toss. And on the average predictions, it is slightly better: 15 points in the wintertime.

Congress has already expressed our need to improve this climate prediction capability by passing the Climate Program Act, and support for NASA's planetary programs could help as well. We must

ask, must we explore the planets to better understand the Earth's climate? The answer to that question has to be no, because, as one of my colleagues has stated, if we lived in a solar system without any other planets but with an Earth like our own, we would have to try to understand the world's climate anyway. However, will the opportunity to study the atmospheres of other planets aid us in solving our climate problems? The answer to that is just as surely "yes."

The variations in climate so important to us are much more subtle than the changes we experience in going from summer to winter. We get into difficulties when a little winterlike weather gets into our summer, and vice versa. An early thaw can mean flooding, it could happen this year. A slightly early frost can mean substantial crop losses.

These subtle changes are the Earth's response to various perturbations in the amount of direct solar energy, a change in volcanic activity, the increase in carbon dioxide and other boundary conditions which affect the Earth's gain of heat from the Sun, the loss of heat to space and the distribution of what remains over the Earth. These small changes on Earth represent the large changes we obtain going from planet to planet. Mars, for instance, can have instant climatic change in one of its giant dust storms. The solar energy that reaches Jupiter and Saturn is very feeble compared to that received on Earth. Yet these planets have enormous wind systems with hundreds of cyclones and anticyclones. The winds near the equator of Saturn roar along at over 1,000 miles an hour, yet it receives only one-hundredth of the Sun's energy we do. What is the reason? We don't know.

Venus has a steady wind system in its ever-present cloud layers, much like the intermittent ones we have in our own tropics. Indeed, the seasonal lag on Titan is so long compared to our own 1½ months on Earth, it is like having the coldest day of winter on the first day of spring.

These data from the planets can be used as a powerful testing ground for the generality of our climate models. We now predict the weather and test for climate variations with numerical models run on very large computers which simulate the behavior of the Earth's atmosphere, and on occasion a planetary atmosphere as well. A good numerical model which works on Earth when provided with the boundary conditions of the planet should work there too.

If the model cannot handle the enormous differences between the planets, how will it handle the subtle differences we experience on Earth? Except for Mercury, all the planets and at least one moon, Titan, have significant atmospheres, clouds, and circulation patterns. These atmospheres are all different from the Earth's and from each other. Each of the planets thus provides an experiment in atmospheric dynamics which can be used to test the theories developed to explain weather and particularly climate on Earth.

Of course, we need much better data on the complete state of the Earth as well, but that could come with suitable funding, with the program outlined in the Climate Act. I have already testified on this subject before a different committee.

In recent years we have seen beautiful images of the outer planets with their cloud systems, and now we have good data on their atmospheres' compositions, structure, and wind systems as well. In addition, thanks to previous support for Congress and over 100 other countries of the world, we have the best description ever of the Earth's atmosphere as a complete global whole. Research results of the global weather experiment in its observational phase was completed in 1979, are now pouring in. Indeed, we are in a position to make a "research killing" if we exploit the rich data supply collected from both the Earth and the planets. Measurements that have been made are a precious commodity, but they are not an end product. Understanding and the ultimate benefits to mankind will come only after study and thought. We should do our best to make use of the data we already have. This analysis process is sufficiently under way to suggest that the potential return is indeed very great. This research effort is now in great jeopardy just at the time when exploitation is ripe.

Even a cursory view of the planetary program in NASA's budget shows research and data analysis, the items that should be increased now that we have such a large, valuable body of data, instead are being sharply decreased by nearly 50 percent in just 2 years. Gentlemen, I think, to prevent this decrease deserves a high priority in your deliberations.

Mr. Chairman, I have tried to show you that we do not have a viable theory of climate. The Earth is a planet too, and we have a unique opportunity to use what we are learning about the atmospheres of other planets for improving the theory of climate we need so badly for the Earth.

While I sincerely believe, as others have stated, that NASA's planetary program deserves support in its own right, it can provide some important practical benefits in the future, since other planets' atmospheres' behavior could be used to rigorously test mathematical models we use to study the climate on the Earth. I hope you and your colleagues can prevent us from being pennywise and pound foolish at this trying time in NASA's planetary program when the opportunities for real progress and possible practical applications are so great.

Thank you for listening.

Mr. FLIPPO. Thank you very much. Doctor, there seems to always be a raging storm over Washington, so we listened very carefully. Thank you. Dr. Levy?

STATEMENT OF DR. EUGENE H. LEVY, ASSOCIATE PROFESSOR, UNIVERSITY OF ARIZONA, AND CHAIRMAN, COMMITTEE ON PLANETARY AND LUNAR EXPLORATION, SPACE SCIENCE BOARD

Dr. LEVY. Mr. Chairman, members of the subcommittee. It is a privilege to appear before this distinguished subcommittee. I have been a member of the Space Science Board and Chairman of its Committee on Planetary and Lunar Exploration for several years now. I am pleased to have the opportunity on the basis of my experience to offer my personal views about the United States planetary program. Mr. Chairman, the more complete statement will be

submitted for the record. I would like to summarize the main points.

I have been deeply concerned with this country's space science program, and with questions of space policy, for a number of years. I am troubled by the continuing erosion of the planetary program that has taken place over the past half decade and that has now quickened to the point of the program's imminent collapse. There has been no planetary spacecraft launched since the Pioneer-Venus launch in 1978; there has been no project initiative approved since the start of Galileo in 1978. Because of delays with the space shuttle, and the lack of other launch capability, Galileo will not be launched until 1985. Because of the planned absence of a fully capable Centaur propulsion stage, Galileo will not reach Jupiter until 1990.

Budgets for the continued operation of existing spacecraft have been reduced to the point where at least three important operating spacecraft will probably be shut down permanently next January, thus depriving the country of valuable and unique new data about Venus and about the solar system. Budgets for the basic scientific research programs have been pared to only 50 percent of the 1981 level, in real terms. This will produce a serious degradation in this country's high-quality basic planetary research. These large budget reductions follow a long and slow decline in basic research support; there is no fat left to cut from the program. We will see the cancellation of many first-class science investigations and the closing of important and unique national facilities.

The budgetary actions and the condition of the planetary program that I have cited are inconsistent with the importance of this activity to the Nation. The U.S. planetary exploration program has made large contributions to human knowledge, has made a major contribution to the scientific and technological strength of the country, and has made an unequalled contribution to the international prestige of this Nation. The challenges that remain in planetary exploration are large; if these challenges are taken up, the planetary program will continue to make such large contributions. Scientific investigation of the solar system may open the path to eventual utilization of extraterrestrial resources. The scientific questions to be answered by solar system studies are among the most profound that face humankind. These facts argue eloquently for the United States to revive its commitment to planetary exploration.

The subcommittee will receive shortly a position paper approved as a statement of policy by the National Academy of Sciences. The statement reiterates the continuing scientific importance of planetary investigations and emphasizes the value of the program to the United States. It is the considered opinion of the Academy as stated in that paper that the scientific and technical value of planetary exploration "argues forcefully for serious consideration of this field in the distribution of Federal research funds."

The goals of U.S. planetary investigations have been developed by the Space Science Board. The specific and detailed objectives are carefully laid out and form the basis of NASA's proposals for new missions. By adhering to these objectives, the NASA program seeks to accomplish the highest-priority scientific measurements and

studies possible with available resources. All program initiatives are judged rigorously against the independent Space Science Board scientific strategies in order to insure that the resources and efforts that are expended will result in real and valuable advances in our knowledge and understanding of planets in a broad scientific context.

Through planetary investigations we discover fundamental facts about how the solar system formed. We learn how planets behave and evolve after they form—how their atmospheres, their surfaces, their climates and environments change throughout geological history. A firm understanding of how planetary environments change is especially crucial to our life on earth as man-made activities grow to the point where they may dominate our own climate. Important clues are waiting for us on the other planets.

Planetary investigations promise to teach us about the origin of life—among the most profound of all questions. Also, the solar system is a laboratory—the largest natural object into which we can enter and learn, from direct experience, about physical laws and how they shape our world.

Our goals for continuing exploration have been shaped by our early discoveries during the last 20 years. Our modern understanding of the solar system reveals the opportunities, the challenges, and the advances that will reward investigations of Venus, Mars, comets, asteroids, the Moon, and the other planets. Our experience with spacecraft missions prompts us to construct a flexible approach to planetary exploration that makes room both for large, comprehensive missions and for simpler, more modest missions. We expect that this approach, if it is allowed to flourish, can form the basis for programmatic stability needed to preserve important scientific capabilities and facilities, and for budgetary flexibility needed to respond to varying economic conditions.

For the past two decades the United States has been the world's leader in exploration of the planetary system. Only the Soviet Union's consistently well-executed program of lunar and Venusian science competed with this country's brilliant planetary program. This situation is rapidly changing, 5 years without a new planetary initiative, and crippling cuts in the basic research program, threaten the viability of continuing U.S. efforts. At the same time firm evidence, as well as informal hints, point to an increasingly vigorous Soviet program. Western Europe is emerging with increasingly ambitious plans and capabilities; Japan is quitely building its ambitions and its expertise. International cooperation is growing to be an important component of planetary exploration. A large number of European national investigators—Eastern and Western—are marshalled under the leadership of Soviet science to study Halley's comet in 1986; I believe that this may set a pattern for the future. The United States moves quietly toward the sidelines to watch.

The growing international involvement in planetary exploration is both a challenge and an opportunity. This subcommittee is better able than I to judge the importance of this challenge to the formulation of national policies. The Space Science Board believes that cooperative endeavors, using pooled resources in areas of mutual interest and complementary capabilities, could be benefi-

cial to the United States. Successful cooperation would require that all parties work from the basis of independently viable national programs and be able to maintain stable and confident commitments to agreed-upon objectives and programs. Conclusions about the readiness of the United States to serious consider international cooperation must be drawn from the structure and content of the present program and its fiscal trends.

Mr. Chairman, I have only a brief time. I have talked about the diminished state of our country's program, about the quality and importance of the science, about the challenges, and about the opportunities that we have to do good things. My colleagues today have prepared more details about some of these things. Let me quickly speak about immediate benefits to society.

The planetary program has a long record of distinctive contributions to our broader technological society. It has provided training for many students who have gone on to apply their knowledge to important national needs in industry, in defense, and in teaching. The planetary program has provoked the development of new technologies and new experimental methods; it has pushed us to new heights of technical expertise and forced us to a deeper understanding of the world in which we live. All of these things already have penetrated into our technological economy to the benefit of the Nation and the world. Planetary science is not unique among the sciences in having such beneficial consequences, but planetary investigations are unique in many of the questions that they ask and in many of the challenges that they put before us. Consequently, many unique benefits have emerged from the planetary program.

The letter inviting my testimony asked for "specific examples which show that the planetary program is an investment in our future." Because I know of no formal studies on the subject, the examples that I can cite for you are anecdotal, from my own experience or that of my colleagues. Nonetheless, I would be happy to discuss an impressive array of examples, covering a broad spectrum of national concerns and interests, in response to your questions later.

Finally, let me turn, as you requested, to the impact of the present budget. (The continuation of the Galileo missions is gratifying, as it is aimed at answering very important scientific questions.) The deletion of the VOIR Venus radar mapping mission is extremely unfortunate. Obtaining a map of Venus that is good enough to allow us to identify the surface-forming processes is critical to the comparative studies of Venus, Earth, and Mars which are needed to achieve an understanding of terrestrial planets. I am hopeful that we will be able to obtain such a map in the near future. We expect that it would have a large impact in helping us ultimately to understand Earth.

We have many important things to do in planetary exploration; many excellent mission proposals could be brought forward even today. I am deeply concerned that the Nation's ability to carry out a program will not withstand the present trend in the planetary budget. Large reductions in the budgets for planetary research and analysis and planetary mission operations and data analysis are crippling this country's ability to continue scientific studies with important spacecraft that were launched years ago, and are causing the abrupt termination of a large fraction of the basic research

activity that generates new knowledge and trains the country's scientists, and are preventing the advanced planning that is needed to bring future missions to reality. The proposed budget for these two line items will produce a crisis sitaution, since they in effect represent only runout costs leading to program elimination. The remedy does not require a large augmentation in the national program. Restoration of these two items to a level approaching that of last year—fiscal year 1981—would, for now, maintain the Nation's basic scientific capability in the planetary program and provide the basis on which a vigorous program could be rebuilt.

Thank you, Mr. Chairman. I will be pleased to answer any questions you may have.

[The prepared statement, plus answers to questions asked of Dr. Levy follow:]

STATEMENT TO THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

Dr. Eugene H. Levy

Associate Professor
University of Arizona, Tucson, Arizona

and

Chairman, Committee on Planetary and Lunar Exploration
Space Science Board

Authorization Hearing: NASA 1983 Fiscal Year Budget Request
February 25, 1982
Washington, D.C.

Mr. Chairman and Members of the Subcommittee:

It is a privilege to appear before this distinguished Subcommittee. I have served as a member of the Space Science Board and as Chairman of the Board's Committee on Planetary and Lunar Exploration for several years. I am very pleased to have this opportunity to offer my personal views about the nation's planetary program based on that experience. Personally, I have been deeply concerned with this country's space science program and with questions of national space policy for a number of years. I am troubled by the continuing erosion of the planetary program that has taken place over the past half decade and that has now quickened to the point of the program's imminent collapse.

The United States is two decades into its program of scientific exploration of the planets. This endeavor has produced deep scientific advances, contributed importantly to the technological vigor of the nation, captured the enthusiasm of the populace, and helped to establish the United States as the world's leader in science and technology. The present state of the program clearly reveals that commitment to continuing solar system exploration is ambiguous at best. There has been no planetary spacecraft launch since the Pioneer-Venus launch in 1978; there has been no project initiative approved since the start of Galileo in 1978. Because of delays with the space shuttle, and the lack of other launch capability, Galileo will not be launched until 1985. Because of the planned absence of a fully capable Centaur propulsion stage, Galileo will not reach Jupiter until 1990. Budgets for the continued operation of existing spacecraft have been reduced to the point where at least three important operating spacecraft will probably be shut down permanently next January, thus depriving the country of valuable and unique new data about Venus and about the solar system. Budgets for the basic scientific research programs have been pared to only 50% of the 1981 level, in real terms. This will produce a serious degradation in this country's high quality basic planetary research. These large budget reductions follow a long and slow decline in basic research support; there is no fat left to cut from the program. We will see the cancellation of many first class science investigations and the closing of important and unique national facilities.

It is the view of the Space Science Board that challenges, opportunities, and benefits that await the United States in solar system exploration indicate the continuing value of this activity to our nation. This Subcommittee will receive shortly a position paper, approved as a statement of policy by the National Academy of Sciences and attached to the submission from the chairman of the Space Science Board. That statement reiterates the continuing scientific importance of planetary investigations and emphasizes the value of the program to the United States. It is the considered opinion of the Academy

that the scientific and technical value of planetary exploration "argues forcefully for serious consideration of this field in the distribution of Federal research funds." (Public statements and published documents of the Committee on Planetary and Lunar Exploration and of the Space Science Board form the basis of much of my statement this morning.)

Mr. Chairman, in this testimony I would like first to summarize the motivations and the goals of the planetary program, and the value which society derives from it as an investment in our future. Then I would like to discuss the state of the program and the impact of continuing reductions. My statement will address only the planetary program, the continuation of which is the vital issue before us. The information gathered through research in each of the major areas of space science is basic to the growth of our knowledge. Most of the important scientific questions are interrelated; continued increase of our knowledge in these areas demands the kind of broad approach to the scientific questions that is contained in the integrated recommendations that have been put forward by the Space Science Board. I am deeply concerned that the nation's ability to carry out a planetary program will not withstand the present trend in the planetary budget. Large reductions in the budgets for Planetary Research and Analysis and for Planetary Mission Operations and Data Analysis are crippling this country's ability to continue scientific studies with important space craft that were launched years ago, are causing the abrupt termination of a large fraction of the basic research activity that generates new knowledge and trains the country's scientists, and are preventing the advanced planning that is needed to bring future missions to reality. The proposed budget for these two line items will produce a crisis situation, since they, in effect, represent only runout costs leading to program elimination. The remedy does not require a large augmentation in the national program. Restoration of these two items to a level approaching that of last year--FY 1981--would, for now, maintain the nation's basic scientific capability in the planetary program and provide the basis on which a vigorous program could be rebuilt.

THE GOALS OF THE PLANETARY PROGRAM AND ITS VALUE TO SOCIETY

The planetary program addresses some of the most profound questions that confront human beings. Beyond that, it also contributes immediate practical benefits to our country. Perhaps most significantly in this regard, the planetary program lays a foundation of knowledge about our world, in its planetary and cosmic context, that will reap practical benefits in future decades.

The broad scientific motivations and goals of planetary investigations have been developed in detail by the Space Science Board. Through planetary investigations we discover fundamental facts about how the solar system formed. These facts are found: in the physical properties and in the chemical and isotopic compositions of the atmospheres, soils, and minerals of the planets; in the valleys, craters, volcanos, and other geological structures on the surfaces of planets; and in the distributions, the compositions, the structures, and the sizes of planets, moons, asteroids, and comets, which make up the solar system. Already we have gained a firmer understanding of some of the processes that resulted in the formation of our world; the promise for the future is yet larger.

We learn how planets behave and evolve after they form: how chemical reactions changed their atmospheres; how internal heat generated volcanos for millions of years before cooling; how oceans were formed and then boiled away (as on Venus) or sank into the ground or froze (as on Mars). We learn about the processes that determine a planet's climate and whether it is stable or susceptible to wild changes and oscillations. This last item is crucial to our survival on Earth as man-made activities grow toward the point where they may dominate our own climate.

We learn about the origin of life and its prevalence in the universe--among the most profound of all questions. For example, future studies of the physical and chemical nature of Saturn's giant moon Titan are expected to yield important clues about the origin of life. Titan's surface may be covered in an organic soup--preserved in a planetary deep-freeze--similar to the soup from which life formed on Earth. Buried under the surface of mars may be clues to a false start for life on that planet, life which failed to survive the planet's changing environment.

The planetary system (more generally, the solar system overall) is the largest astrophysical system into which we can enter and learn from direct experience. Exploration of the solar system and of the bodies in it is one of the ways that we experience the laws of nature and how they act to shape our world. Many natural phenomena are governed by processes that are discernible only over long periods of time or in very large objects; these generally are not even susceptible to study in the laboratory. Scientific exploration of the solar system provides our only way of getting "hands-on" experience, over a wide range of conditions, with the many large-scale phenomena that shape the behavior of planets, stars, and galaxies.

Our goals have been shaped to a large extent by our early explorations and studies that have taken place over the last

twenty years. This first work has answered many questions about the solar system; it has also shown us the opportunities, the challenges, and the potential advances that will result from our continuing efforts. The solar system is a repository of important information and a vast natural laboratory.

Solar system science is not separated and distinct from other major scientific activities. Growth in our comprehension of the universe and of our world requires that we attack scientific questions on a broad front that encompasses laboratory and earth-based experiments, in situ investigation of accessible extraterrestrial bodies and regions of space, and deep-space astronomical observations. Investigations of the planets will advance our understanding of Earth in major--perhaps crucial--ways. Several additional examples will serve to illustrate these points and to outline some of the major problems and opportunities that are now before us.

In Earth science our ideas about the behavior of our own planet, in areas ranging from continental drift to climatic variation, will remain tentative so long as our view is confined to only one planet. Confident understanding will emerge when we can set our theories against the challenge of phenomena also on the other planets. In addition, observations of other planets stimulate our ideas and provoke us to examine yet unconsidered possibilities.

Man's influence on the global environment is no longer negligible, and it grows steadily larger. For many years scientists have been concerned that man-made influences could trigger large and deleterious changes in conditions at Earth's surface. Speculation about the possible instability of our environment is now sharply focused as a result of geological evidence, discovered by spacecraft in the past decade, that Mars has undergone drastic climatic change during its history. Mars appears to us a nearly dry, dead planet. But the scars on its surface testify to a dynamic and exciting history--exciting at least on a cosmic time scale. The canyons and seeming sedimentary deposits tell us of a Martian history perhaps with flowing water and certainly with a climate and environment far different from the ones that Mars presents to us today. These large changes in the Martian environment call into question our understanding of the constancy of terrestrial climates and their stability.

Planetary investigations already have had a significant and valuable influence on our understanding of Earth's atmosphere. To take one example, computational techniques needed to understand the influence of aerosol propellants on Earth's ozone layer were first developed to understand the upper amosphere of Venus. It is essential that we understand the variations in terrestrial climate and the sensitivity of our

atmosphere to subtle changes before we inadvertently trigger a dangerous change on Earth; comparative study of the planets offers one of the best paths to a sound understanding.

The evolution of Earth's surface and interior is another field of scientific inquiry where our deepening comprehension of the planets will surely prove essential to finding the answers to central questions. The recently developed theory of plate tectonics--continental drift and mantle convection-provides the foundation upon which we organize our thinking about most geophysical phenomena. Plate tectonics is ultimately responsible for most dangerous earthquakes and volcanos. Apparently, it is also responsible for many of the complicated processes that have created ore deposits and other mineral wealth. Yet the origin of Earth's tectonic behavior is poorly understood. Both Venus and Mars are crudely similar to Earth, but seem to have evolved in vastly different tectonic regimes. By learning and comparing the details of their evolutionary histories, as well as important facts about their internal constitution, we will come to understand how planets--including our own Earth--work internally.

There are whole classes of primitive objects in the solar system--comets and asteroids--which have not even been approached by spacecraft. Many of these bodies are believed to contain the oldest materials in the solar system. They are probably remnants and fragments of the original rocky and icy bodies that coalesced to form the Earth and other planets. We believe that these small bodies were formed with too little internal energy to produce the heat and geological turmoil that has obliterated most of the evidence of the primordial character of other planetary material. The information that would be obtained through spacecraft investigations of comets and asteroids would make unique and decisive contributions to our grasp of the conditions and processes of solar system formation.

Human society may eventually expand its economic activity beyond Earth and into extensive regions of the inner solar system, if only to gather resources. Since asteroids have not melted, they did not form dense metallic cores as did Earth. Hence they should retain on their surfaces large amounts of many of the valuable metals that are rare on Earth's surface. The time before which we can expect such resources to become economically important is uncertain and, arguably, it may be very long. However, sustained scientific investigations would reveal most of the information needed to assess the resource potential of extraterrestrial bodies, and at a pace sufficient to ensure that the United States will not be left behind in any important developments.

Astronomical studies aimed at elucidating the conditions and processes of star formation in the galaxy are tied closely to our growing knowledge of the details of the formation of our own star--the sun--and its system of planets. The generalities of star formation, as revealed by broad astronomical studies, and the deep detail of the solar system's history that can be revealed by in situ studies are complementary sets of information, each unique and each essential to our eventual comprehension of the formation of stars and planets.

Turning to a final example, it has become apparent in recent years that large systems of plasma and magnetic field are common in the universe, and that their dynamical behavior is responsible for many highly energetic astrophysical phenomena. The solar system offers a variety of magnetized plasmas for our investigation. In fact these are the only of such systems accessible to in situ study; they are therefore crucial to guide our understanding of such objects throughout the universe. The plasma systems that we can enter in the solar system include, among others, Earth's magnetosphere--energized by the solar wind and perhaps analogous to some extragalactic radio sources--and the magnetosphere of Jupiter--energized in part by that planet's rotation and perhaps partially analogous to pulsars.

The goals of U.S. planetary investigations have been developed by the Space Science Board. The specific and detailed objectives are carefully laid out and form the basis of NASA's proposals for new missions. By adhering to these objectives the NASA program seeks to accomplish the highest priority scientific measurements and studies possible with available resources. All program initiatives are judged rigorously against the independent Space Science Board scientific strategies in order to ensure that the resources and efforts that are expended will result in real and valuable advances in our knowledge and understanding of planets in a broad scientific context.

The goals for continuing planetary science have been shaped by our early discoveries during the last twenty years. Our modern understanding of the solar system reveals the opportunities, the challenges, and the advances that will reward investigations of Venus, Mars, comets, asteroids, the Moon, and the other planets. Our experience with spacecraft missions prompts us to construct a flexible approach to planetary exploration that makes room both for large, comprehensive missions and for simpler, more modest missions. We expect that this approach, if it is allowed to flourish, can form the basis for programmatic stability needed to preserve important national scientific capabilities and facilities, and for budgetary flexibility needed to respond to varying economic conditions.

For the past two decades the United States has been the world's leader in exploration of the planetary system. Only the Soviet Union's consistently well executed program of lunar and Venusian science competed with this country's brilliant planetary program. This situation is rapidly changing. Five years without a new planetary initiative, and crippling cuts in the basic research program, threaten the viability of continuing U.S. efforts. At the same time firm evidence, as well as informal hints, point to an increasingly vigorous Soviet program. Western Europe is emerging with increasingly ambitious plans and capabilities; Japan is quietly building its ambitions and its expertise. International cooperation is growing to be an important component of planetary exploration. A large number of European national investigators--Eastern and Western--are marshalled under the leadership of Soviet science to study Halley's comet in 1986; I believe that this may set a pattern for the future. The United States moves quietly toward the sidelines to watch.

The growing international involvement in planetary exploration is both a challenge and an opportunity. This Subcommittee is better able than I to judge the importance of this challenge to the formulation of national policies. The Space Science Board believes that cooperative endeavors, using pooled resources in areas of mutual interest and complementary capabilities, could be beneficial to the United States. Successful cooperation would require that all parties work from the basis of independently viable national programs and be able to maintain stable and confident commitments to agreed upon objectives and programs. Conclusions about the readiness of the U.S. to seriously consider international cooperation must be drawn from the structure and content of the present program and its fiscal trends.

Mr. Chairman, I have spoken mainly about the scientific questions, challenges and opportunities, and about the more general and, perhaps, longer-term value to society of the United States' planetary program. I have said little about the immediate value and benefit to society. This is inevitable when one speaks of basic scientific research. Indeed, one of the characteristics that distinguishes basic research from applied research is that, while applied research hews closely to those activities that promise immediate economic benefit, basic research seeks to enlarge our knowledge. However, it is just this knowledge that builds the foundation on which future applications will rest. Society's commitment to vigorous scientific research rests, in part, on confidence that it will be rewarded by future benefits. I need not review how amply rewarded such confidence has been in the past.

Nonetheless, the promise of future benefits should not obscure the real and important immediate benefit that society

reaps from its active program of planetary space research. The planetary program has a long record of distinctive contributions to our broader technological society. It has provided training for many students who have gone on to apply their knowledge to important national needs in industry, in defense, and in teaching. The planetary program works at the technological frontiers of human activity. By probing as deeply as we can into the way the world works, we are forced to develop new scientific and engineering techniques that otherwise would not occur to us. The planetary program has provoked the development of new technologies and new experimental methods; it has pushed us to new heights of technical expertise and forced us to a deeper understanding of our environment. Many of these things already have penetrated into our technological economy to the benefit of the nation and of the world. Planetary science is not unique among the sciences in having such beneficial consequences, but planetary investigations are unique in many of the questions that they ask and in many of the challenges that they put before us. Consequently many unique benefits have emerged from the planetary program.

Your letter requesting my testimony asked specifically for "examples which show that the planetary program is an investment in our future". I am pleased that you raise that question explicitly. Often we lose sight, especially those of us engaged in basic scientific research, of the fact that a variety of motivations underlies society's support of national activities. Indeed, one of the values of society is that, by bringing together very diverse motivations and talents, we collectively can enable accomplishments, progress, and benefits that alone would be beyond our reach. In this regard the nation's planetary program is one of the most brilliantly successful examples of our society's accomplishments. Unfortunately, however, we scientists rarely devote a large fraction of our time to constructing the arguments and marshalling the facts that you seek. We are immersed in the science and in the technology; we see the benefits to society--both long-term and immediate--all around us; it sinks into our bones; we are satisfied and we get on with the job.

I know of no formal studies which document the examples you seek in a systematic way. The examples that I have are anecdotal from my own experiences and from the experiences of my colleagues. Nonetheless, I can cite an impressive array of examples covering a broad spectrum of national needs and concerns. The examples were collected by me, informally, and from a few telephone calls to a few close colleagues. Technological developments, ideas, experimental methods, and measurement techniques that come directly from the planetary program have been applied to areas of critical national need. These areas span a large range including, for example,

communication technology, earthquake and avalanche prediction, resource exploration geology, and national defense. I would be most happy to discuss some of these examples in detail in response to your questions later.

THE STATE OF THE PLANETARY PROGRAM AND IMPACT OF REDUCTIONS

Our expectations of scientific return and of benefits to society from solar system exploration should be reflected in the vigor of the nation's planetary program. The evolution of the program has produced a large disparity between our expectations and the vigor of the program over the last five years. Support for planetary exploration has declined steadily during that time. The inescapable conclusion is that, unless corrective measures are taken, this country will slowly, surely, and perhaps inadvertently, end its exploration of the planets. One important measure of the health of the planetary program is the frequency of new mission starts. This has declined to the point where, at present, there is only one approved mission under development--the Galileo mission to Jupiter, which was started in 1978, and which has suffered continuing postponements as a result of delays in Space Shuttle and upper stage development. With the deletion from this year's proposed budget of the VOIR mission to Venus the nation will go at least six years without a new start in planetary exploration.

This slowdown in the pace of planetary exploration is not a result of any lack of programmatic opportunities or initiatives brought forward within the Space Agency. A large number of scientifically and technically excellent missions have been designed which meet the rigorously applied criteria of the Space Science Board. These missions have failed to be supported in any of the recent fiscal years. Part of the reason for this was that shuttle-induced postponements of Galileo added continually to the cost of that mission and kept the planetary budget artificially inflated, without adding to our national accomplishments.

A rational approach to maintaining an adequate national launch capability would have involved retention of Expendable Launch Vehicles as well as development of the Shuttle for manned space flight. This would have allowed the country to use whichever vehicle was best suited to any particular task. Failure to follow such a rational approach has cost the nation significantly. The U.S. planetary program is but one important national activity that has suffered; this Committee is perhaps in a better position than I to assess any other deleterious effects in the recent past as well as in the foreseeable future.

At the same time, development of a fully capable propulsion system to allow staging of high-energy interplanetary spacecraft from the Space Shuttle has vacillated for many

years. We have seen several upper stage propulsion systems brought forward which, in concert with the Space Shuttle, would have provided high capability propulsion facilities, would haveserved many long-term needs of planetary exploration, and probably would have important uses in Earth-orbital applications. These systems--notably the wide-body Centaur rocket and the Solar Electric Propulsion system--failed to be supported. I do not perceive that decisions on these matters have been made on the basis of a clear, coherent, and broadly informed view of long-term national needs. We are continually caught in the bind of, on the one hand, being unable to proceed with missions because we have no adequate launch capability and, on the other hand, being unwilling to develop a launch vehicle because we have only one or two firmly planned missions in mind that will use it. So far we have not succeeded in approaching these long-term questions on the basis of our long-term needs. The best that I can do here is to reiterate a much earlier recommendation of the Space Science Board: "that NASA adopt a policy that places the planning and development of launch capabilities for unmanned space exploration in a 10- to 20-year perspective and that focuses on the requirements of our long-term objectives"; recent events, I believe, have shown the wisdom of that recommendation. A rational, long-term approach to national spacecraft launch capabilities will demand, from the Congress and from the Administration, a level of foresight and willingness to plan ahead that has not been apparent in recent years.

During the early stage of the FY83 budget preparation serious consideration was apparently given to the abrupt termination of the U.S. planetary program. Steps toward the rapid closing of the program included cancelling Galileo and VOIR, abandoning the acquisition and analysis of data from all operating spacecraft (Pioneer 6-9, Pioneer 10 & 11, Pioneer-Venus, and Viking) except for Voyager, and reducing basic research and advanced planning programs to the level of runout costs for ongoing activities in order to begin a phased close-down. The budget that has been submitted to this Congress for Fiscal Year 1983 shows that the Galileo mission is retained, apparently reflecting a decision that the NASA planetary program is to be continued. However, none of the other program elements have been restored to a sustaining level.

The FY83 budget proposal must be considered in light of the present state of the planetary program. The country's ability to do planetary exploration depends on the expertise of scientists, engineers, and institutions to carry out scientific planetary investigations, to design missions, and to design, build, and operate spacecraft in deep space. The United States' singularly impressive ability to do all of these things is the result of accomplishments and experience accumulated over more than twenty years, and is admired the world over. We

are in the process of dismantling all of these essential elements.

We are facing a several-year interval of time during which the engineers and technicians who design and build spacecraft for planetary exploration will have nothing to do. Lacking such continuing challenges these talented and experienced people will go elsewhere. A major national capability will be lost unless we soon reinvigorate our planetary exploration program.

In the science programs the proposed budget terminates data acquisition from nearly all of the nation's operating, deep-space spacecraft and greatly reduces, for the second year in a row, the United States' basic scientific planetary research in university laboratories and national centers. As a consequence our response to the scientific challenges that I listed earlier will be wholly inadequate. Data gathering, analysis, and the synthesis of new knowledge will be halted in many important areas. The planning, the content, and the execution of missions depends on the health of these activities. The budgets for Research and Analysis and for Mission Operations and Data Analysis support the development of new instrumentation forged in response to new knowledge of the planets and to meet the challenges of our scientific objectives and the challenges of planetary environments. These budgets support the analysis which turns data into real information. These budgets support the theoretical and laboratory work that is essential to generation of new knowledge. These budgets support the studies and developments needed to plan future missions. These budgets support the training of graduate students who are essential to the future health of our technological society and economy. These integrated activities are vital to the continuity of the planetary program and, in a larger sense, to all of the major advances in knowledge of the planets and to the useful purposes to which that knowledge can be applied.

I believe that the budgets submitted to the Congress for the U.S. planetary program in Fiscal Years 1982 and 1983 are mistakes; I believe that they are inconsistent even with the Administration's policy of sustaining important basic scientific and technical capabilities through this period of economic difficulty. I believe that the Congress should exert its wisdom and its responsibility to see that this mistake is rectified. Restoring the budgets for Research and Analysis and for Mission Operations and Data Analysis to at least the level of 1981, in real terms, would be an important step that could be taken now without a large augmentation in the national program. It would preserve the nation's basic capabilities in planetary science for the present. And it would provide a foundatin upon which recovery of the national program in this area could be built.

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Addendum to Statement

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

Answers to Written Questions

Dr. Eugene H. Levy

Authorization Hearing: NASA 1983 Fiscal Year Budget Request
February 25, 1982
Washington, DC

Answers to Questions
Eugene H. Levy

1. Is the Explorer Program a reasonable model for a planetary exploration program, given more funding? If not, why not?

The important feature of the Explorer Program is that it provides a continuing and stable base level of flight activity in areas of the Earth-orbital science program. This stability is extremely beneficial to national science activities as it allows long-term planning of a rational sequence of science investigations in the few areas that the Explorer program now serves. This continuing base program along with the larger missions that are approved as individual projects provides a flexible approach to meeting scientific objectives.

This general approach, if coupled with an adequate overall budget and level of programmatic activity, would be good for the United States' planetary program. A flexible mix of missions, including a stable sequence of modest-size projects (perhaps in the Explorer model) together with a smaller number of somewhat larger and more ambitious projects, could provide an excellent solar-system exploration program.

* * *

2. Would you advocate holding public congressional hearings to help establish a concensus space policy?

I believe that the United States should formulate and adhere to a well thought out space policy. This policy should clearly set forth the national interest in space activities and set out an agenda to realize those interests. Several aspects of space activity are essential to the long-term national interest, ranging from basic scientific research to commercial and national security needs. It is important that the U.S. space program be based on an informed and mature understanding of national needs and objectives.

So far, no well constructed and forward looking policy or agenda has been forthcoming from this administration or from recent administrations. It seems reasonable to me that the congress should fill this leadership vacuum.

* * *

3. Could the U.S. participate usefully in international cooperative planetary programs given the FY 1983 funding projections?

I have consistently advocated and worked in support of an appropriate role for the United States in international cooperation in space science. In my view, real international cooperation will not be successful or useful unless all of the participants have independently strong national programs. The presently projected FY 1983 budget for planetary research will erode the U.S. program to the point that the nation's basic research capability in this area will be seriously damaged. Unless steps soon are taken to restore support for basic research activities then I do not believe that this country will be in a strong position to play a major role in planetary exploration, either on its own or with cooperative partners.

* * *

4. What specific practical benefits have flowed from the planetary program?

A proper answer to this question would require an extensive discourse that would be out of place here; there is a large complex of societal benefits that have derived from the planetary program and that promise to continue. I would like to point to one or two examples. Analytical techniques that were developed for the analysis of lunar and meteorite samples (in order to meet the challenge posed by our efforts to understand the origin of the solar system) are now being used to gain diagnostic information in the nuclear weapons development program. These new analytical approaches allow the recovery of important information, and in ways that protect the workers from exposure to large amounts of hazardous material. Similarly in the nuclear power industry, new environmental protection and safety monitoring needed to comply with regulations put in force since the Three Mile Island incident rely on analytical techniques and expertise generated in the lunar and meteorite analysis programs. I have been informed by sources within both of these programs that, for techniques and personnel, they have been heavily dependent on the research efforts in the planetary program. Further I have been told that following the recent and proposed reductions in these research activities it is not clear from where these crucial and growing needs will be satisfied over the next ten years.

Other examples could be given; but I think it is clear that basic research programs provide the foundation of ideas, people, and technology on which our modern technological society depends. The planetary research program is not unique in this regard. But the planetary program responds to many unique challenges, and as a consequence provides unique payoffs.

5. (a) What percentage of the planetary research community funding comes from NASA? Is this funding mainly from the planetary research and analysis budget? What are the other funding sources?

(b) Are the research and analysis activities significantly reduced by the NASA FY 1982 budget?

(a) I do not have the precise figures; but for practical purposes all planetary science research in the United States is supported through NASA. Small amounts which may fall into this category from other sources are not large enough to affect any conclusions about the state and health of the activity in this country. Most of the basic research efforts, which form the foundation of the program and the core of the continuing activity, are supported out of the research and analysis budget. Of course during the execution of specific missions, the scientific teams associated with the project are supported partially and temporarily from project funds.

(b) Yes. In real terms the cumulative effect of the budget reductions for FY 1982 and FY 1983 nearly halves the planetary basic research and analysis program in the United States.

* * *

6. (a) Is there enough money in the NASA budget to keep the planetary research community alive until new missions are developed?

(b) With the current budget, what will happen to the planetary research teams at universities? At the NASA centers?

(c) What effect will this have on graduate students and their future careers?

(a) No. However, as long as some money remains in the budget, some fraction of the national research base will be kept intact. The question that we should ask ourselves is whether we will retain a research and training capability that meets our national needs. To that question I believe the answer is a clear "no".

(b) Large numbers of excellent research groups carrying on important scientific research will have to be disbanded. These groups embody important knowledge, capabilities, skills, and expertise that were accumulated during years of work. Reconstituting these national resources will be difficult, time consuming, and expensive.

(c) Graduate students will be forced out of this field of research. This will happen because of several reasons: many of the research groups in which graduate students are trained will go out of existence;

the students will perceive that no future career opportunities exist in the planetary sciences; and finally, the research assistantships by which graduate students are supported, and through which much important research is accomplished, will no longer be available. This will contribute to a long-term national problem, as the technical expertise that fuels this nation's technological economy is generated in large measure by the training of students in basic research programs such as the planetary program.

* * *

7. If Congress were able to add funds to the planetary programs, your advice on how to allocate them would be helpful. Please list missions and activities (operations or data analysis) in priority order.

(a) Where should we direct the first $20M added?

(b) The second $20M?

Unless a restoration is made to the budget that approaches the full $40M needed to bring the basic planetary program near its 1981 level, the national research capability in this area will be badly damaged. In order to minimize the effects of the damage the NASA planetary office will need flexibility in allocating available funds. I think that the Congress should be most concerned with seeing that funds targetted to repair damage in the planetary program actually get to their target (to the Planetary Research and Analysis and Planetary Mission Operations budgets) and should leave the detailed management issues to the appropriate managers.

* * *

8. Mars data analysis will not be funded in FY 1983. Will most of the analysis be completed by this time?

No! In a real sense the job of organizing the data and getting it into a form useful for continuing research is well along. But the all important task of using that treasure of information to synthesize a deeper understanding of Mars and of the terrestrial planets is only in its early stage. Reductions in basic research support, of which this is only one recent example, are extremely short-sighted. The costs of strong basic research activities are relatively small in comparison with national resources; these reductions mortgage the future of the nation's scientific prowess. The proposed budget is penny-wise and pound-foolish.

* * *

9. As you know, NASA is proposing to use the shuttle to repair the partly failed Solar Maximum Mission. The total cost of this repair is likely to approach $100M (if the launch cost is included). NASA has stated that the Solar Max has already achieved its primary objectives.

(a) Is the cost worth the expected return?

(b) Where would you rank this repair mission in importance relative to other missions?

(a) The repair of the Solar Maximum Mission is in my view a worthwhile undertaking. There is no doubt that the data returned will be very valuable. In addition, it may be a useful exercise for the Space Shuttle system. The major part of the real cost will probably be in manned activity rather than in the science side of NASA. I do not believe that any major science programs should be sacrificed for the repair mission.

(b) I am most concerned about a possible tradeoff between the repair mission and continued support for the basic scientific research programs. I do not believe that such a trade should or needs to be made. The science program overall uses relatively small amounts of money and the leverage on payoff to the nation is very large. It is disturbing to me that amounts of a few million dollars are haggled over in the science programs while billion dollar amounts are more casually disposed of elsewhere in the budget. I believe that we need to apply a more realistic and forward thinking budgetary perspective, and, again, to cease our penny-wise, pound-foolish approach to national scientific programs.

* * *

10. (a) What benefits does a space platform promise for planetary science? What liabilities?

(b) What benefits does a manned space platform promise for planetary science? What liabilities?

I believe that we should approach the question of a space station or space platform from an integrated view of our long-range national goals in space activity. The major drive for a manned operational capability in Earth-orbital space is not coming from the science programs; the country has other legitimate goals and objectives for the space program. We should not mix these when the result could be detrimental.

If the nation decides for nonscientific reasons to proceed with a space platform (obviously intended to lead to a manned presence) then we must also ensure that our important scientific programs--which serve

essential national interests in their own right--are not sacrificed or impeded. It may be that, once the engineering characteristics and logistical capabilities of a platform are known, significant use will be made of the platform for scientific purposes. For the presently projected planetary program, use of a platform will be very secondary and perhaps fiscally and logistically detrimental. The essential technical question for the planetary program is concerned with the availability of adequate launch capabilities.

In the long run, operational capability in Earth-orbital space or a capable science platform could be assets to our planetary program. During any development of such capabilities, however, it is essential that we ensure continued strength in our basic scientific research programs and not mortgage them in a short-sighted manner.

* * *

11. (a) If NASA abandons their SEPS effort are future planetary missions compromised?

(b) If indeed we are not going to have Centaur, would you suggest using SEPS with IUS for missions to the planets?

I have long supported development of the SEPS independently of the fate of the Shuttle-Centaur launch system. Solar Electric Propulsion provides a unique and important deep-space capability for long-term national needs. In addition, it would advance a basic technology that I believe will find important use for maneuvering structures in Earth orbit.

At the the present time, this nation's planetary program is compromised by the lack of a coherently planned and capable deep-space propulsion system. We are continually caught in a "chicken and egg" syndrome where missions cannot be planned for absence of a launch system and launch system development is denied because only one or two missions are firmly planned to use it! This again is a reflection of the nation's recurrent inability to proceed with a well-planned forward-looking policy and agenda for scientific and other space activities. If we were able to define a long-term program for planetary and other important space activities, SEPS is one of the systems that could play and important role.

* * *

12. Dr. Stofan testified that NASA "may have to stop operations of the Infrared Telescope temporarily."

(a) What can this facility uniquely contribute to astronomy? To other disciplines?

(b) Will the facility provide data to keep the planetary community alive while we wait for the next spacecraft encounter with a planet (Voyager II with Uranus, in 1986)?

(c) Would you support a joint NASA/scientific-community study to determine the long range future of the telescope facility?

The Infrared Telescope Facility should without question remain in operation, as should many other parts of the nation's planetary program. The combination of a uniquely excellent siting and the quality of the instrument makes the Infrared Telescope Facility probably the best of its kind in the world, making contributions to all major astronomical pursuits, including planetary studies. However, it is important to realize that only a limited amount of information can be gained from telescopic studies of the planets. As important as the telescopic data are, and as important as this telescope is, most of the major questions of planetary science cannot usefully be approached by astronomical studies. Most of the most crucial data can only be gotten through spacecraft investigations. These, together with laboratory and theoretical, work constitute the core of the modern planetary science which so impressively has advanced our understanding of the solar system in recent years.

The crucial issue in keeping the planetary community alive is to provide adequate support for the basic research and analysis and data-gathering activities that would be crippled or eliminated under the Administration's presently proposed budget. Keeping the Infrared Telescope Facility in operation should be part of that.

I would not support a joint study of the future of this facility; it would be a waste of time. This facility is a component of a complex of facilities and research activities that should be supported by the United States. The resources needed to properly support these important research activities are modest on a national scale and in comparison with the benefit to society. A protracted debate aimed only at the Infrared Telescope Facility would distract us from this main policy issue before us.

* * *

13. NASA has announced that the Lunar Curatorial Facility may be shut for a period of time. What effect will this have on the research community? What effect, if any, will it have on the lunar samples?

Much of the research on lunar samples, meteorites, and cosmic dust will be inhibited or stopped by a closing of the Curatorial Facility. Together with the large reductions in research support, this would have the effect of nearly eradicating a whole generation of accumulated analytical knowledge and capability in an important area of science. People cannot be put into a deep-freeze; a hiatus in the program would simply cause the existing analytical groups--many of which are world leaders--to dissipate, resulting in the loss of a major national resource which has produced important benefits to society (as I tried to indicate in the response to an earlier question). The Lunar Curatorial Facility was designed to protect the samples for a time unattended; it is hoped that this treasure of material would not be severely and irretrievably damaged by a temporary closing.

Mr. FLIPPO. Thank you very much. Mr. Brown?

Mr. BROWN. I am not sure that I can ask any questions which will improve and clarify the impact of what you gentlemen have said. I gather that what we are seeing here are reductions which cut into the basic scientific competence that has been developed in this field, probably could only be restored by possibly $40 million to allow us to continue. Do you wish to venture any views as to why portions of the defense program have been most adversely impacted in these programs? Some of you have pointed out that actually there are beneficial increases in some of the other space science activities, the telescope, for example, and several other items.

Dr. MORRISON. Mr. Brown, I cannot offer any speculation as to how this came about, but I would like to add my emphasis to what you said, that it appears to be a policy change. In the past, although total budgets have gone up and down in space science, it has been a strong commitment at NASA to a balanced program. I would submit that this year's budget appears to abandon that goal of balance, as represented in the sharp decline in planetary exploration.

Mr. MCGRATH. Let me ask about your use of the term balance. It reminds me that we had that term used in here before another subcommittee in connection with the National Science Foundation, where they referred to a balanced budget. In that program the balance consisted of eliminating science education in order to maintain at some considerably lower level, but still keep in existence, some programs in research and social sciences.

It occurs to me that what you are describing, although probably least significant in terms of funding of NASA's programs, 3 or 4 or 5 percent or something like that, has probably done the most in terms of making progress in science education. Would I be correct in this?

Dr. LEVY. Absolutely.

Dr. SUOMI. Yes.

Mr. BROWN. Perhaps a whole generation of young people have had their views of the universe modified, and perhaps been stimulated, to aspire to careers in science as a result of the work that has been done and the results of that work in planetary exploration.

Dr. LEVY. I can comment on that. Three of us sitting here at this table are all university faculty members. We deal with the young scientists who will fuel our technological society, in the future. I know I have, and I assume that my friends here have, discussed this question with our colleagues at our home institutions and elsewhere. It is the view of virtually all of my colleagues that the space science program has been the single most effective means for attracting young people to careers in science and technology in the United States. It is not the only one, but we believe it is the single most effective one.

Mr. BROWN. I don't hold that the success of our national program at inculcating reasonable interests in science rests upon the Federal programs, particularly some kinds of Federal programs. But there has been a growing resurgence of activity in the field of public education in science as represented by an increasing number of publications, by the devotion of more time in the media, and I

see nothing undesirable about this. I just don't want to see us cut out the inspiration for what I think is a large share of this growing public and private interest in scientific activity.

Dr. LEVY. I think you put your finger on it. The reason for the increased interest and the increasing number of publications is because this activity is taking place, so that there are accomplishments to report. If the new accomplishments go away, I think we will see that increased interest and that increased attention wither away with perhaps a time delay, but equally rapidly

Mr. BROWN. Thank you very much. Mr. McGrath?

Mr. MCGRATH. Mr. Chairman, I can't help but note the contrast in the testimony given by Dr. Morrison tnis year with the testimony he gave last year, when he was defending the budget. I would just want to ask that one question that was asked by Mr. Hollenbeck on whether or not the 2 year additional trip of the Galileo will affect the scientific objectives of that particular mission.

Dr. MORRISON. Mr. McGrath, I think that the trip time per se has very little influence on the scientific objectives. What has been a problem is that associated with the longer trip time has been the inability to carry as much fuel on the Galileo spacecraft to carry out the full-scale orbital tour at Jupiter. So from a scientific point of view, the problems are, first, that we simply have to wait 2 years longer and thus expand this data gap, and second, that we may not obtain as long and comprehensive an operation of the Galileo Orbiter as we might otherwise.

Mr. MCGRATH. In that explanation you would be more in favor of the upper stage of the IS?

Dr. LEVY. I would be in favor of carrying out the Galileo mission as originally envisioned. I would have to look carefully at the capability of the Centaur for the proposed launch date to see how one can best accomplish the original goals.

Mr. MCGRATH. Thank you.

Mr. FLIPPO. I noticed, Dr. Levy, in your testimony that there is firm evidence as well as important hints pointing to an increasingly vigorous Soviet program. Could you give us any information on that? Are you suggesting some type of Sputnik-type breakthrough on the part of the Soviet Union, or is there some spectacular mission that you have some information about that?

Dr. LEVY. Let me preface my remark by saying that the information that one gets about the Soviet program is always of several kinds. Some of it, as I said, is firm evidence, and some of it is discussion of plans that scientists will have with one another on a more informal basis. We know on the basis of plans that the Soviets are willing to discuss with us openly that they intend to carry out a vigorous program, certainly through the eighties, involving several missions to Venus in addition to their Halley's Comet mission. Beyond that, we have been given numerous hints of various kinds about other goals involving missions to other planets, including Mars and sometimes they even talk to us about missions to Jupiter. There is various speculation about how real the latter one is.

But one of the impressive things about the Soviet program scientifically is that there has been an inexorable march forward with a program that has some continuity to it. Perhaps the best display of

that is their continuing sequence of studies of the planet Venus, which they represented to us they fully intend to continue.

Mr. FLIPPO. Could you elaborate on the nature of the Venus——

Dr. LEVY. Yes. They have a continuing sequence of increasingly capable and better designed missions to Venus, landing on the surface of Venus and conducting extensive moderate-term scientific analysis.

Mr. FLIPPO. You expect the Soviets to land on Venus in the very near future?

Dr. LEVY. Yes. They have already done so and they will do so several more times throughout the eighties.

Mr. FLIPPO. At the same time we are cancelling the VOIR—the administration is.

Dr. LEVY, I could add that I have engaged in discussions as a member of a NASA delegation to a joint working group meeting. We discussed with the Soviets the kinds of things that we might do jointly in a cooperative manner in the 1988 opportunity, when they will be on the surface of Venus and when we had intended to fly the VOIR mission. I didn't realize at the time how totally empty our side of the discussion was.

Mr. FLIPPO. Each of you have testified about the severe impact of the budget. If Congress could see its way clear to—say you could come up with another $20 million, this is always a difficult question, I know, but suppose Congress came up with another $20 million in this area. What would be your priorities as to where we should put it?

Dr. MORRISON. Mr. Flippo, I mentioned a number of specific items in my testimony which would absorb most of that $20 million, and which I think are of outstanding importance. But I think that the managers at NASA are fully aware, perhaps more than I would be, of where the needs are greatest. If you were to put $20 million or $40 million back into the budget, my personal recommendation would be to allow NASA the freedom within the planetary program to distribute those funds. But clearly they would need to be earmarked for the planetary program.

Mr. FLIPPO. Would that include data analysis? I believe Dr. Suomi was interested in that area.

Dr. SUOMI. Yes. I would put as much possible in data analysis. We spent a lot of money to go out there. The stuff is just beautifully good, and the students and scientists are dying to analyze it. And we will have some great stories to tell after we have the time. But to go out there and then bring home the bacon and throw it in the wastebasket is something I frankly cannot understand.

Mr. FLIPPO. Gentlemen, thank you very much for your very informative testimony. It will be extremely helpful to us.

This concludes our hearing. The next hearing is scheduled March 2, 1982, at 2 p.m. in 2318 Rayburn. Thank you.

[Whereupon, at 12:16 p.m., the hearing was adjourned.]

1983 NASA AUTHORIZATION

TUESDAY, MARCH 2, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to recess, in room 2318, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Brown, Bouquard, Hollenbeck, McGrath, and Lowery.

Mr. FLIPPO. The subcommittee will come to order.

Today we continue our hearings on NASA's budget request for 1983, with several distinguished witnesses who can comment on the Agency's applications programs. We propose to take the witnesses in two panels. Our first panel will consist of representatives of committees that have had a broad overview of NASA's applications programs and have provided advice to NASA managers.

Originally we had scheduled Mr. James W. Plummer, chairman of the Space Applications Board of the National Academy of Engineering but unfortunately he was taken ill. However, we have present today two other members of the Space Applications Board, replacing Mr. Plummer: Mr. Thomas F. Rogers, now a private investor, will present the statement and will be accompanied by Dr. Elizabeth Young.

Mr. Rogers has had a long career in space applications in both the civil and military sectors, while Dr. Young is president of the Public Service Satellite Consortium. Joining them on the panel will be Dr. John W. Firor, immediate past chairman of the NASA Space Applications Advisory Committee, chartered by NASA and consisting of non-NASA experts. Dr. Firor is a solar physicist and a radio astronomer at the National Center for Atmospheric Research.

Given the fact that technology transfer is being zeroed, that the 30/20 gigahertz program is being cut, and that LANDSAT will end after D' , we are concerned that NASA may be quietly phasing out their applications programs. We hope to get testimony today as to where these programs should be going.

We will introduce the second panel a little later. At this time I would like to recognize the ranking minority member, the gentleman from New Jersey, Mr. Hollenbeck.

Mr. HOLLENBECK. Thank you, Mr. Chairman. I also join in welcoming our distinguished panel members to the subcommittee.

All too often, Mr. Chairman, we forget how important the applications portion of the NASA budget has been and is to this country. Past contributions in remote sensing, space communications, and technology transfer have spunoff a number of companies that are utilizing NASA-derived products and technology in moneymaking ventures. One of the most dynamic examples of a space applications spinoff is the communications satellite industry.

Early work by NASA, using the fledgling expendable launch vehicle service, proved that communications satellites could work. The long-term, expensive R. & D. that was required to prove the feasibility of such a concept could only be undertaken by a Federal agency. The U.S. space communications industry has now grown to international preeminence by improving and increasing the size and capacity of these satellites.

However, I am concerned that we may be closing the door on the advanced 30/20 gighertz program by not going ahead with a flight demonstration program. Foreign competition is, as we know, progressing in this area, and we may end up by buying our future advanced communication satellite systems from overseas. We know how much of a loss this would cost the U.S. aerospace industries in revenues.

We are seeing similar reductions in remote sensing, since there is no follow-on spacecraft past LANDSAT D'. It appears to me as well, Mr. Chairman, that NASA is reducing their efforts in the applications area, and I am concerned about this trend. I look forward to the testimony of our panel members today to help us in the fiscal year 1983 this budget authorization process.

Thank you.

Mr. FLIPPO. Thank you.

We will, of course, accept your statements in total for the record. Please feel free to summarize as you deem appropriate, and proceed.

STATEMENT OF THOMAS F. ROGERS, PRIVATE INVESTOR, ACCOMPANIED BY DR. ELIZABETH YOUNG, PRESIDENT, PUBLIC SERVICE SATELLITE CONSORTIUM

Mr. ROGERS. Thank you very much, Mr. Chairman. I want to be sure that the record shows that this statement has been prepared in close collaboration with Mr. Plummer. We want to thank you for this opportunity to convey to you our views on some important matters developed in our close association with the Nation's civil space applications program over the past many years.

We look forward to use of the Shuttle's capabilities to make important contributions to the practical use of space. We believe that NASA should now solicit from the non-Federal remote sensing data user communities, suggestions as to what data could be obtained on an experimental basis from sensors on future shuttle flights. NASA should now work out cooperative arrangements with the private sector to use the shuttle for commercial remote sensing, especially in the important natural resources area.

The trend in civil space systems will see fewer but much heavier spacecraft, and a booster able to take these payloads from the shuttle to geosynchronous orbit will soon be essential. The Space Sci-

ence Board has also concluded that a high-energy upper stage is essential for some future space science missions, and a lack of a Centaur-like, high-energy upper stage for the Shuttle will leave us all seriously short.

While our country has obtained important returns from the space program, none of us is satisfied at all with the magnitude of the practical benefits that we have as yet received from our quarter-century investment in it, and we continue to have serious reservations about the way that our civil space applications programs are organized, conducted, and funded.

A number of changes in NASA and elsewhere in the Executive Branch give us concern:

In the new NASA Office of Space Science and Applications, the office responsible for observation of the Earth's resources has been subsumed within the office responsible for exploration of planets other than Earth.

The budget request for a program that puts space to practical use remains at less than one-half of that for space science. The request of $320 million for applications in fiscal year 1983 is 4 percent less than in fiscal year 1982, even though the overall NASA budget request of $6.6 billion is 13 percent higher, and for space science is 20 percent higher.

Demonstrations of space applications and the related technology transfer program are now being eliminated.

Efforts to exploit remote sensing data are now to be concentrated in an agency other than the one that will develop the sensor technology. The satellite communications area is being sharply curtailed.

These steps, Mr. Chairman, should raise serious questions in the Congress regarding the future of the Nation's space applications area.

It is painfully clear in the real commercial, industrial, and public service delivery worlds, that completion of successful R. & D. does not guarantee that important new goods, services, or processes will then be provided. The only major successful space technology transfer that has taken place to date is that of satellite communications. The country has yet to harness the abilities and interests of its Federal Government and its commercial, industrial, and public service delivery sectors so as to assure that major earthly benefits flow from our space R. & D. investments.

Decisions to confine Federal space applications activities to scientific inquiry and technological development alone, on the basis that sufficient work will thereby have been done to allow the non-Federal sectors to incorporate the results into their ongoing activities—that is, to eliminate so-called technology transfer activities—is simply and fundamentally incorrect. The Federal Government now is second-guessing investment decisions about the marketplace which only the private sector can make. Here the Federal Government should be a listener, not a talker, and a businessman's administration should have particularly well-qualified listeners.

Having made great investments in space applications, the Federal Government should be prepared to finish the job—as it is doing with the Shuttle program—I repeat, as it is doing with the Shuttle program—by carrying on those further analyses, experiments, and

trials required for the non-Federal public and private sectors to develop and provide new goods, services, and processes and use them.

A decade ago, U.S. leadership in satellite communications appeared to be so secure that the Federal Government decided to stop R. & D., assuming that the private sector would pick it up. It soon became clear that this decision was a mistake. Our private companies could not make the large, long-term, and technologically risky investments required. Other countries, seeing an opportunity, commenced their own vigorous R. & D. programs.

Consequently, NASA was urged to reinstate a major innovative program in this area. Since then, some of the country's best scientists and engineers have worked with NASA to delineate such a program, and it is now ready for major funding commitment. This program provides for further important industrial and commercial growth and for protection of this country's international economic position.

However, two arguments are now advanced to truncate this program: that industry can be expected to make the major investment required to develop the new system technology and to conduct flight tests; and that DOD programs will meet civil needs.

The private sector position of years ago remains unchanged today. While willing to invest in cooperative R. & D. activities and—upon satisfactory completion of these activities and with expanding market promise—also willing to make the investments required to capture such markets, they are on public notice that they cannot afford to make the multihundred million dollar experimental spacecraft investment required.

The satellite communications business is large, it is vigorous, it is competitive. If any company could see its way clear to making such investment and thereby capture the financial high ground, it would do so, and without waiting for the Federal Government. Why don't the businessmen in our Government understand and accept this free marketplace judgment?

R. & D. on military satellite communications will help the civil area in much the same way as, say, military R. & D. activities in the armored personnel carrier area assist our civil automotive industry—that is to say, some, not much, certainly not enough. Since military satellite communications systems must survive under physical and electronic attack and require easy and quick transportability of the surface segments, the complexity and cost of their components are such as to render them unacceptable for competitive civil use.

Some 15 years ago, a concerted effort was made by the Department of Defense and COMSAT to design a joint military-civil satellite communications system. This instructive effort failed. No evidence has been advanced to us to suggest that today's circumstances are any different, nor would I expect any.

In our considered judgment, NASA's satellite communications program should proceed vigorously, with appropriations of some $30 to $40 million, so that it can commence technology and system tests involving an in-orbit spacecraft. Fortunately, NASA now has chosen Dr. Burton Edelson as its Associate Administrator for Space Science and Applications. I say fortunately because he is broadly

experienced in the development of both military and civil satellite communications systems.

The Wall Street Journal recently reminded us that, and I quote,

> In many areas of technology the United States has lost the worldwide edge it once enjoyed. France, for example, is ahead in nuclear power. West Germany leads in chemicals, Japan in optics and metallurgy. As a consequence, U.S. companies now must look abroad for know-how to bring home * * *.

This has not yet happened in the satellite communications area. The seed corn planted by an earlier NASA in the satellite communications area allowed a rich and a new economic harvest to be reaped by our country, and the Congress should see that today's NASA is determined to do at least as well.

Mr. Chairman, the provision of data from observations of the Earth and its atmosphere from space is unprecedented to mankind. Perhaps it should not have surprised us that those expected to use such data would need as long a time to learn how to do so as was required to develop the space technology itself. However, such has been the case.

The NASA budget contemplates completing Landsat D, launching it this year, and then completing the backup spacecraft. Beyond this, essentially all activities will be turned over to NOAA. However, the NOAA budget is based unrealistically on the expectation of a transition to industry in the very near term, and a gap in Landsat coverage and data flow is almost inevitable.

We continue to have a chicken and egg situation with Landsat which the Federal Government does not fully appreciate. A major market will not develop without sufficient opportunity to learn how to use the space data by making many and various long-term user trials, but industry will not invest the great sums of money required to provide the space data without seeing such a market.

Therefore, the Federal Government should prompt the transition of Landsat data reduction and handling to the non-Federal sectors as quickly as possible, should continue to conduct vigorous, innovative, market- and service-related technology transfer experiments—just as it is doing in the Shuttle program—but should defer the transition of the satellite as premature.

Another concern is the future of oceanographic and meteorological satellite activities. A year ago plans for a joint NASA/NOAA/Navy oceanographic satellite were dropped. This was a blow in two ways: We are convinced that an operational oceanographic system would be a national asset, valuable in a cost-effective way to both civil and military users, and we regret that a genuine effort to develop a joint military-civil system has been abandoned.

In the meteorological area, it appears that over two decades of cooperation between NASA and NOAA is about to end. NASA will soon stop developing new instrument concepts and prototype devices for which NOAA has never been funded nor staffed. Either NOAA must now develop and fund a competence in space technology or, more likely, the Nation will have no new advanced operational meteorological satellites, with serious implications for the safety of lives and property.

The concept of a permanent manned presence in space is again being advanced. DOD came close to embarking upon an approach to realizing such a presence—the manned orbiting laboratory—and

NASA has been studying it for many years. If the justification for such a program is a military requirement, we can expect the DOD to pursue it. If the justification is to be found in the civil science and applications areas, the Nation's leading professionals in these areas should be involved in its delineation from the beginning.

The Landsat program demonstrated that we must not put the cart before the horse. Potential users from the science and applications communities, especially ones from without the aerospace industry, should be involved with NASA in user requirement studies prior to the initiation of any technological development activities, and the Congress should not approve such activities before the satisfactory completion of such studies.

The administration may be giving consideration to cutting back some civil space applications areas on the basis that they can be better conducted by the DOD. Any such consideration should command the immediate attention of the Congress, for it would be a serious national mistake. To advance the explanation that such a step is being contemplated to strengthen our national security could introduce an unfortunate note of semantic confusion.

The Nation's security encompasses both civil and military elements, and is enhanced by having an educated, mobile, healthy, and free citizenry; a strong economy; a pride in our national accomplishments and international postures; a confidence in our national prospects; and an adequate military capability and will. The civil space programs are expected to make continuing major improvements in our national security, improvements that cannot be traded off for those in the military area.

Mr. Chairman, that completes my statement prepared in collaboration with Mr. Plummer. I would appreciate it if I could also submit for the record a statement that reflects some additional views that I have of my own——

Mr. FLIPPO. We would be most pleased to receive it.

Mr. ROGERS. And if I might also take perhaps 2 more minutes of your time to give an oral summary of it.

Mr. FLIPPO. Indeed.

Mr. ROGERS. Mr. Chairman, space program leader after leader has promised the general public that, in due course, it could expect major economic benefits from the space program—enlargement of employment, increased tax base, more competitive foreign trade, increased productivity in public service delivery—that is, that it would realize a reasonable economic return on its great space program investments. Particularly in communicating with the Congress, the space program leaders have treated space applications as a rhetorical darling.

Apart from the satellite communications area, these promises have not been fulfilled to any extent commensurate with the magnitude of the investment made. There is now clear evidence that, except in the Shuttle program, the executive branch will not follow through and do those things, in addition to conducting scientific studies and developing space technology, that need to be done to position our non-Federal public and private sectors to obtain these benefits.

Mr. Chairman, the Congress has consistently been closer to the needs of the general public in the space application area than has

the executive branch, and I believe that the time has now been reached for the Congress to move to change these grim circumstances by insisting upon better accountability from the executive branch in this area.

Therefore, I suggest that the Congress ask the executive branch to make an annual report on what the objective accomplishments of the space program have been during the past year, outside of the science and technology areas. That is, what accomplishments have been made in assisting the potential providers and users of space-related goods, services, and processes, and what benefits have been realized?

These accomplishments should be described, insofar as possible, in quantitative terms so that these investment results can be compared directly with the public expenditures in the space area. In other words, I suggest that the Congress ask for a form of bottom line report of the public and private profits from the Nation's space program, profits from which could come funds to pay for the entire space program itself.

Second, I would suggest that for the next few years the Congress make it explicitly clear that in its future consideration of authorization and appropriation requests in the civil space area, it intends to look at the space applications area first, then everything else. I am specifically not asking that financial support of space science or space technology be reduced but, rather, that the non-Federal public and private sector economic interests in our country for a while should be given particular and specific congressional attention.

Mr. Chairman, I remain convinced that the promises of earlier years can be met and should be met but, sad to say, I am now just as convinced that, left to itself, the executive branch may well not do so. Therefore, the Congress should see that it does do so.

Thank you very much, Mr. Chairman.

[The prepared statement plus an additional statement by Mr. Rogers follows:]

Statement by

Thomas F. Rogers

before the
Subcommittee on Space Science and Applications
of the
Committee on Science and Technology
U.S. House of Representatives

2 March 1982

Mr. Chairman, James Plummer, Executive Vice President of the Lockheed Missiles and Space Company, who is chairman of the National Research Council's Space Applications Board, is ill, and has asked me to appear before you in his stead. My statement has been prepared in collaboration with Mr. Plummer.

With me today is another member of the Space Applications Board, Dr. Elizabeth Young, who is president of the Public Services Satellite Consortium.

On behalf of all of the other members of the SAB as well, we want to thank you for this opportunity to convey to you our views on some important matters, developed in our close association with the nation's civil space applications program over the last ten years.

The Board's charter and a list of its current members are attached to this statement.

For the purpose of this hearing, you should know that my relevant professional experience has been that of a scientist, engineer and research program administrator, most of it in the space applications area.

We are all satisfied by the accomplishments to date in the Shuttle program, and we are are pleased at its use, on the second flight, to conduct space applications experiments. We look forward to use of the Shuttle's capabilities--and particularly its ability to utilize people in space--to make important contributions to the practical use of space, and suggest that these capabilities now should be emphasized by NASA. We believe that NASA should now solicit, formally, from the non-Federal remote sensing data user communities, suggestions as to what data they could use that could be obtained on an experimental basis from sensors employed on other such Shuttle flights. And. NASA should now actively encourage the private sector to come forward and work out with it cooperative arrangements to use the Shuttle for commercial remote sensing purposes, especially in the important area of natural resources.

We expect that the trend in space systems designed for practical use will see fewer but much more sophisticated, much larger and much heavier spacecraft which must be placed in geosynchronous orbit. A booster able to take these payloads from the Shuttle to geosynchronous orbit will soon be essential. Our sister board, the Space Science Board, has concluded that a high-energy upper

stage is essential for some future space science missions, and it seems clear to us that plans that do not provide a Centaur-like high-energy upper stage for the Shuttle will leave us seriously short.

A number of steps related to the space applications area taken recently by the Administration give us pause. While our country has obtained important military, scientific, political and cultural returns from our nation's space program, none of us is satisfied at all with the magnitude of the practical benefits that we have as yet received from our great investment in civil space activities over the past quarter of a century. And we continue to have serious reservations about the way that our civil space applications programs are organized, conducted and funded.

While the reasons advanced by the NASA Administrator for the organizational changes that have resulted in combining the space science program and the space applications program appear cogent from the perspective of his office, a number of consequent and related changes in NASA and elsewhere in the Executive Branch give us concern:

- in the new NASA Office of Space Science and Applications, the office responsible for observation of the earth's resources has been subsumed within the office responsible for exploration of planets other than earth;

- the budget request for a program that puts space to practical use for man's benefit remains at well less than one-half of the amount requested for space science;

- the request of $320 million for applications in FY 83 is 4% less than planned in FY 82, even though the overall NASA budget request of $6,580 million is 13% higher and the request for space sciences is 20% higher;

- so-called demonstrations of space applications and the related technology transfer program are being eliminated;

- efforts to exploit remote sensing data are now to be concentrated in an agency other than the one that will develop the sensor technology to generate these data; and

- the satellite communications area is being sharply curtailed.

Taken all together, these steps--explicitly and by implication--should raise serious questions in the Congress regarding the future of the nation's space applications area.

It is painfully clear to anyone who has had experience in the real commercial, industrial and public service delivery worlds that completion of a successful research and development program, in itself, simply does not guarantee that important new goods, services or processes will then be provided. In the space applications area, the only major successful technology transfer that has taken place to date (apart from such important public policy-related activities as atmospheric ozone depletion measurements) is that of satellite communications--long recognized to be a unique case. The country has yet to harness the abilities and interests of its Federal government and its commercial, industrial and public service delivery sectors in such a way as to assure that other major "earthly" benefits flow from our

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space R&D investments. Decisions to confine Federal space applications activities to scientific inquiry and technological development alone on the basis that it will thereby have done sufficient work to allow the non-Federal sector to incorporate the R&D results into its ongoing activities, and decisions to eliminate so-called technology transfer activities, are simply and fundamentally incorrect. The Federal government is now "second guessing" investment decisions about the marketplace which only the private sector can make. In this area, the Federal government should be a listener--not a talker--and a businessman's Administration should have particularly interested and well qualified listeners.

The Federal government, having made the great investments in science and technology that it has in the space applications area generally, should be prepared to finish the job (as NASA is doing with the Shuttle program) by carrying on those further analyses and experiments required for the non-Federal public and private sectors to provide and use the resulting goods, services and processes in a continuing fashion.

A decade ago the United States leadership in long distance, wideband, fixed, civil satellite communications appeared to be so secure that the Federal government decided to stop satellite communications R&D assuming that the private sector would pick it up. It soon became clear that this decision was a mistake. Our private companies could not make the large, long term and technologically risky investments required. Other countries, seeing an opportunity, commenced their own vigorous R&D programs. Consequently, NASA was soon urged by its internal advisory groups, by various business and professional associations, and encouraged and guided by an SAB study completed five years ago, to reinstate a major, innovative program in this area. Since then, some of the country's best university scientists and communications and aerospace engineers have worked with NASA to delineate such a program and it is now ready for major funding commitment. This program provides for conservation of the electromagnetic spectrum and the geostationary orbit and the perfection of transmission technology and techniques that should provide for further important industrial and commercial growth and for protection of this country's international economic position.

At this late moment, two arguments to truncate this program are being advanced: that industry can be expected to make the major investment required to develop the new system technology and to conduct flight tests; and that Department of Defense satellite communications programs will meet civil needs.

The private sector position of years ago remains unchanged today. While it is willing to invest substantial sums in cooperative R&D activities that would utilize the sophisticated spacecraft to be developed and orbited by NASA and, upon satisfactory completion of these activities and with expanding market promise, also willing to make the further substantial engineering, production and sales investments required to capture such markets, they are on public notice as saying, consistently, that they cannot afford to make the multi-hundred million dollar spacecraft investment required. The satellite communications business is a large, vigorous and competitive business. If any company could see its way clear to making such an investment and thereby capturing the economic and financial "high ground", it would do so--and without waiting for, or dealing with, the Federal government. Why do not the businessmen in our government understand and accept this free marketplace judgement?

R&D on military satellite communications certainly will help the civil area in much the same way as, say, military R&D activities in the armored personnel carrier area assist our civil automotive industry--that is to say: some, not much, certainly not enough. Any professional who has had to design military and civil satellite communications systems knows that military systems require operational survival under physical and electronic attack on either the space or surface segments, and require easy and quick transportability of the latter--all of which so increases the complexity and cost of their components as to result in their being unacceptable for competitive civil use.

It is well to recall that, some fifteen years ago, a concerted effort was made by the Department of Defense and the Communications Satellite Corporation to design a joint military-civil long haul satellite communications system. This effort failed. It failed for the simple reason that the military and civil operational requirements and financial circumstances are so different that they could not be encompassed within one technological envelope. No evidence has been advanced to us to suggest that today's circumstances are any different.

In our considered judgment, the NASA satellite communications program should proceed vigorously at an appropriation level of some $30-40 million so that it can commence technology and system tests involving an in-orbit spacecraft at the earliest moment. Fortunately, Mr. Chairman, NASA now has chosen Dr. Burton Edelson as its Associate Administrator for Space Science & Applications--I say fortunately because he is specifically and comprehensively experienced in the development of both military and civil satellite communications systems.

Mr. Chairman, only last Friday the Wall Street Journal reminded us that "In many areas of technology the United States has lost the world-wide edge it once enjoyed. France, for example, is ahead in nuclear power; West Germany leads in chemicals; Japan in optics and metallurgy. As a consequence, U.S. companies [now must] look abroad for know-how to bring home...." This has not yet happened in the satellite communications area. Let us remember that our country's civil satellite communications activities, led by imaginative and determined NASA scientists, engineers and administrators, lay a basis for important productivity improvements in our commercial and public service sectors, for increases in employment and tax base, and for securing international trade benefits. We have all seen how the seed corn planted by an earlier NASA in the satellite communications area allowed a new and rich economic harvest to be reaped by our country. The Congress should see that today's NASA is determined to do at least as well.

Mr. Chairman, the provision of data from observations of the earth and its atmosphere from space is unprecedented to mankind. In retrospect, perhaps it should not have surprised us that those of our national and international institutions expected to use and provide such data would need to take at least as long a time to learn to do so as was required to develop the space technology. But such has been the case. The Board is seriously concerned that no viable plan for transitioning Landsat to the private sector has yet come forth. Preliminary discussions between the Federal government and industry have involved propositions in which the companies involved want essentially a "no risk" arrangement guaranteed by the government--something quite different from what the government has in mind. In the meantime, the NASA budget contemplates completing Landsat D, launching it this year and

then completing the back-up spacecraft. Beyond this, essentially all activities will be turned over from NASA to NOAA. However, the NOAA budget is based, unrealistically, on the expectation of a transition to industry in the very near term, and a gap in Landsat coverage and data flow is almost inevitable.

Landsat data users must be sure of at least two things: faster and better data handling, and continuity of data provision, since the people involved in value-added data services must invest in expensive capital equipment and must establish and meet delivery dates for those products over a sufficiently extended period of time. Thus, we continue to have a chicken and egg situation with Landsat which the Federal government does not fully appreciate: a major market will not develop without the opportunity to learn how to use the space data by various long-term trial uses; but industry will not invest the great sums of money required to provide the space data without perceiving such a market.

Under these circumstances, the Federal government should prompt the transition of the data reduction and handling part of the Landsat program to the non-Federal sectors as quickly as economically possible, should continue to conduct vigorous, innovative market- and service-related "technology transfer" experiments and analyses--just as it is doing in the Shuttle program--but, for now, should defer consideration of the transition of the satellite.

Another concern of the Board is the future of oceanographic and meteorological satellite activities. As of a year ago, plans for a joint NASA/NOAA/Navy oceanographic satellite were dropped. This was a blow in two ways: we are convinced that an operational oceanographic space system would be a national asset, one valuable in a cost effective way to both civilian and military users, and we regret that a genuine effort to develop a joint military-civilian system has been abandoned.

In the meteorological area, it appears that over two decades of cooperation between NASA and NOAA is about to end--or at least change dramatically and for the worse. NASA will soon stop developing new instrument concepts and prototype devices. NOAA has never been funded or staffed to undertake this kind of work. Either NOAA must now develop and fund a competence in space technology development or, more likely, the nation will have no new advanced operational meterological satellites for the foreseeable future. The implications of this decision for the safety of lives and property in this country and abroad are serious.

I would now like to make two more observations regarding the practical use of the Shuttle.

We expect that most of the initial payoff from materials experiments in space will come in the form of better scientific and technical understanding, leading to improvements in processing of materials on the ground. I understand that Dr. Millar will discuss this important area later today. Also, we understand that life science experiments in space selected so far for the Shuttle are confined, unfortunately, to physiological concerns of astronauts and space passengers, rather than encompassing, as well, experiments relevant to health on earth, and we intend to inquire into this matter.

The concept of a permanent manned presence in space is again being advanced. Some fifteen years ago the Department of Defense came close to embarking upon an approach to realizing such a presence--the Manned Orbiting Laboratory--and NASA has been studying it for many years. If the essential justification for such a new, major space program is a military requirement, we can expect the Department of Defense to pursue it appropriately. But if the justification is to be found in the civil space science and civil space applications areas, the nation's leading professionals in these areas should be involved from the beginning in its delineation. The Landsat program has demonstrated at great cost that we must not "put the cart before the horse": potential users from the science and applications communities--especially ones from outside the aerospace industry--should be involved with NASA in user requirements studies prior to the initiation of any technological development activities, and the Congress should not approve such activities without the satisfactory completion of such joint studies.

Apparently some serious consideration is now being given within the Administration to cutting back some civil space applications areas on the basis that they can be better conducted by the Department of Defense. Any such consideration should command the immediate attention of the Congress, for it would be a serious national mistake. Furthermore, to advance the explanation that such a step is being contemplated in order to strengthen our national security could introduce a note of semantic confusion into discussion of this serious matter. The nation's security encompasses both civil and military elements, and is enhanced by our having an educated, mobile, healthy and free citizenry, a strong economy, a pride in our national accomplishments and international postures, a confidence in our national prospects--and an adequate military capability and will. The civil space science and applications programs are expected to make continuing major improvements in our national security. These needed improvements simply cannot be traded off for those also needed in the military area.

Thank you, Mr. Chairman.

NATIONAL RESEARCH COUNCIL
ASSEMBLY OF ENGINEERING
2101 Constitution Avenue / Washington, D.C. 20418

Charter for the Space Applications Board

The Space Applications Board of the National Research Council will:

Provide to all elements of the Federal Government, including Congress, expert independent advice and broad judgment on the national program for the useful application of space systems in terms of issues, appropriate activities, international relations, and related priorities, emphasizing ways to augment its positive effects on society and diminish or eliminate its negative effects.

Collect and analyze information on the developing needs of concerned segments of the user community and inform them of the state-of-the-art and potentials of space techniques and capabilities.

Stimulate active collaboration among the various components of the governmental and industrial communities whose combined interest and resources will be required to achieve maximum benefit from space applications.

Conduct timely follow-up and impact analyses to assess the effectiveness of recommendations, determine the causes for success or failure, and recommend appropriate remedial actions.

Provide guidance on organization and management problems to the extent necessary to achieve the objectives of the space applications program.

1 October 1981

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Additional Statement by
Thomas F. Rogers

before the
Subcommittee on Space Science and Applications
of the
Committee on Science and Technology
U.S. House of Representatives

2 March 1982

Mr. Chairman, in contrast to my previous statement, this further statement for the record (and my brief oral summary thereof) reflects my own personal experience and judgement regarding the present circumstances of the nation's space applications program.

I should note, at the outset, that almost all of my professional activities as a scientist, engineer, R&D program manager and Federal official during the first decade of the space age were concerned with military space applications, and for the past dozen years I have been an advisor to many of the nation's civil space program leaders with respect to civil space applications. I would judge that, in various professional roles, I have continued to be as close to the country's space applications interests and activities, over a longer time, than most other professionals in the United States.

Throughout this time I have seen the genesis of formal civil space applications activities and their growth to respectable dimensions. Always too slowly, and oftentimes limited in its understanding of proper applications goals and the activities beyond natural science and space technology required in the applications area, nonetheless, considerable progress has been made in the space applications area--often, frankly, with the sufferance of those in the space area more interested in space science, space transportation and space technology.

Now I fear that this progress, achieved with great pain and at a cost of some $10 billion, is seriously threatened, and that the likelihood that our country will obtain a satisfactory return on this investment is in doubt.

The space program serves its scientific constituency well. The universities look to it to help defray its overhead costs and individual scientists look to it for employment, prestige and excitement.

The space program serves its aerospace constituency well. The aerospace industry looks to it for profit and a "leg up" on the development of commercial goods and services, and individual aerospace engineers look to it for employment and an opportunity to solve challenging technological problems.

The space program serves the international political and the cultural interests of the general public well. All of us take satisfaction from the competitive success of the Apollo program and the opportunity to see the surfaces of the moon and the planets of our solar system.

But there is another constituency that has not been well served by the space program: the general public, in its expectation that, in time, and in

various ways, its economic life will be improved a little, its financial burdens modestly reduced, its local commercial and industrial interests on the farm and in the cities served somewhat better.

Space program leader after space program leader over the past decade has promised the general public that in due course it could look to major economic benefits from the space program, and that with the enlargement of employment, increased tax base, more competitive foreign trade, and increased productivity in public service delivery, the general public would see large private and public economic benefits and a satisfactory economic return obtained on its space program investments.

But, except in the satellite communications area, these promises have not been fulfilled to any extent commensurate with the magnitude of the public investment made, and there is now the distinct possibility that they will not be. For there is clear evidence--some of it outlined in my earlier statement--that, except in the Shuttle program, the Executive Branch may not follow through and do those things that need to be done, in addition to scientific inquiry and space transportation and technology development, to position our non-Federal public and private sectors to see that these benefits are realized in fact.

Mr. Chairman, I particularly do not wish to be understood to imply that anything should be taken away from the space science, transportation and technology areas in order that these promised benefits be obtained by the general public. Rather, I do wish to be understood to say that our nation's space program leaders should have the same sense of dedication and responsibility to realizing space applications goals as they do to realizing space science, space transportation, and space technology goals. I am saying that the space applications area warrants the analagous kinds of attention, brain power, organizational and programmatic innovation, and funding support as these other areas. The space applications area, always the rhetorical darling of the space program leaders, has never received its proper share either of the attention of our space program leaders or of the resources made available by the public in the space arena, and now even that share is being reduced.

Mr. Chairman, we must appreciate that the funds expected to advance the space science and the general space technology areas, except for what might be described in other arenas as the long-term expectation of "trickle down", are, in effect, consumption expenditures. Even the Shuttle program is still such a consumption expenditure, and it will remain so until it can be seen to pay off, i.e., when the economic value of the payloads that it lifts into orbit becomes great--payloads which, to a great extent, are expected to spring from the space applications area. And, unless the economic value of these payloads become very large, indeed, then whatever else of value the Shuttle program may provide us, it will not be judged an economic investment success.

The space applications area, explicitly dedicated as it is to the relatively near-term production of new goods, services and processes, and to increases in productivity in our public and private sectors are, in effect, investment, not consumption, expenditures. They are expenditures that we all look to to provide the economic and financial wherewithall to continue to support space scientists and space technologists. Yet, today, a businessman's administration is opting for a relative de-emphasis on investment relative to consumption in the space area.

Mr. Chairman, I must now, particularly under these specific circumstances, make a painful but respectful observation. To put it simply, I do not see that the Congress is insisting upon satisfactory accountability from the Executive Branch in the space applications area. The Congress has consistently been closer to the needs of the general public in the space applications area than has the Executive Branch, and I believe that the time has now been reached for the Congress to move to change these grim circumstances by insisting upon better accountability.

In this regard, I would make two specific suggestions.

I would suggest that the Congress give thought to asking the Executive Branch to make an annual report on what the objective accomplishments of the space program has been during the past year outside of the science and technology areas. That is, outside of the universities and outside of the aerospace industry, what accomplishments have been made to assist the potential providers and users of space-related goods, services and processes? And I would suggest that these accomplishments be described, insofar as possible, in quantitative as well as qualitative terms so that they can be compared with the public expenditures in the space area. In other words, I suggest that the Congress ask, each year, for a form of "bottom line" report of the past year's "public and private profits" from the nation's space program in contrast, and in addition to, the usual budget submission documents which describe the promise of the coming year and the taxpayer's cost of realizing that promise.

Secondly, I would suggest that, at least for the next few years, the Congress make it explicitly clear that in its future consideration of requests for authorizations and appropriations in the civil space area by the Executive Branch, it intends to look at the space applications area first--then, everything else. I repeat, I do not wish to be understood that I am asking that the interests of the space program constituency groups in science, transportation and technology be de-emphasized, or that funds to these area be reduced, but, rather, that the constituency group made up of the non-Federal public and private sector economic interests in our country, for a while, should be given particular and specific Congressional attention.

Mr. Chairman, I remain convinced that the promises of earlier years can be met, and should be met. I remain convinced that a modest fraction of the resources being allocated to our civil space program, if concentrated with skill, imagination, determination and simple commitment to "follow through", could, over time, produce economic benefits seen to be sufficient to pay for our entire civil space program.

But, sad to say, I am now just as convinced that, left to itself, the Executive Branch will not do so. Therefore, the Congress should see that it does do so.

Mr. Chairman, in Sunday's Washington Post, Charles Peters, in another context, succinctly observed: "...the essence of democracy is that the agencies of government must be accountable to the people's elected representatives."

I can only trust that the Congress will now move to obtain a satisfactory accountability from the Executive Branch in the Federal space applications area.

Mr. FLIPPO. Thank you, Mr. Rogers, for your statement.

Mr. Firor, I believe we would like to have your testimony at this time and then we will come back for questions to the entire panel. If you would proceed, Dr. Firor.

STATEMENT OF DR. JOHN W. FIROR, SOLAR PHYSICIST AND RADIO ASTRONOMER, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Dr. FIROR. Thank you, Mr. Chairman.

You have distributed a brief statement which I prepared. I will not read from it, with your permission, but will just talk informally about the main points.

I have not been close to the space program in the last year, after what seems like 20 years of continuous service on a number of advisory committees. I was a bit surprised to be asked to testify but, trying to turn this situation into an advantage, I have examined the budget request and the program plans that I had available to see what trends have occurred in the last year, when I was not helping run things.

I think I have identified some trends which may be hazardous. Tom Rogers already touched on them; you, Mr. Chairman, mentioned them in your introduction; Mr. Hollenbeck mentioned them. So I will be repetitive to some extent, but viewing the plans from a different point of view.

I work at an atmospheric science laboratory and our particular interest is in observing the atmosphere, but the committee I chaired and the other ones I have served on have looked over the whole applications program.

First I would like to comment on the reorganization, somewhat differently from Mr. Rogers, in that I see it as a favorable trend. My committee always found it awkward in looking at applications as distinct from science. Looking at the atmosphere of a planet has many overlapping features to looking at the atmosphere of the Earth. Many of the instruments one uses to observe planets and stars have analogs or direct applications in looking at the Earth. Many of the attitudes that must be brought to making a successful space venture are the same.

Therefore, I have felt and I think many members of the committee I chaired would feel that the close connection between applications and space science is basically favorable. The real, bottom-line issue is not the details of organization but whether those people thinking about how to do space applications and proposing missions get support within the agency and within Congress and from the American people. I think the new structure, though, is favorable in that regard.

This brings me to the issue that Tom Rogers touched on, and that is the connection of the applications program with the user community. In the satellite communications area that Tom spoke about, we have an extreme example. The relevant industry already knew how to transmit messages. Here then was simply a new, faster, wider band technique of transmitting messages. The industry was ready to go, and it jumped in.

At the other end of the spectrum is Landsat, where there was no user community, there was no agency set up to do the job. Here I agree completely with Tom Rogers that we have to be patient, to develop the user community. We have to do more demonstration projects, perhaps, more of them than we think initially would be wise. We have to try different things rather than just let the community develop slowly on its own.

I recall with some embarrassment the early days of the meteorological space program, in which a large number of people—and I guess I was included—were skeptical of the benefits that it might provide. We thought, "What good is a picture of clouds? We all know what a cloud looks like, and photographing it from above is not much different from photographing it below. How will that help us forecast the weather?"

We were wrong in at least two ways: One was in the fundamental way. A photograph of a cloud does help us if we get enough of the world in the picture at the same time. The grander pattern of clouds surprised us and told us things about the Earth and its atmosphere that we didn't know. It told us about how currents cross the equator, something that was not known. It told us the Northern Hemisphere was rather fundamentally different from the Southern Hemisphere. It told us about the large-scale organization of weather systems, and all of that changed our thinking in rather fundamental ways.

The second way in which we were wrong was in assuming that photographs would be the end of the line, that we could not measure hard numbers from satellites. But we can measure temperatures at various levels in the atmosphere. On special occasions we can measure winds. We can measure humidity now; in the last few years all of these have been demonstrated. And these numbers can be injected into the forecast systems and improvements are already underway.

We learn from that experience that even when we have a moderately well-identified user community—in that case the weather service and its users—even when we are already oriented to technical solutions, we still underestimate the capability of the view from space. I think that is even more true in other area of space applications.

Hence, in order to produce a useful, cost-effective, beneficial space applications system, it seems to me—and this has been the view of the committees that I have served on—NASA must be prepared to push well into demonstration projects, must be prepared to try various approaches that mimic applications. NASA cannot become an operational agency, of course, but it can do enough tests to demonstrate the variety of techniques that might be applied, and which in the process train the user community to know what to ask for.

Operational people generally do not ask for major improvements. If I have a daily task and someone says, "What do you need?" I need a new computer or a new tool that helps me to do what I already know how to do. I do not usually ask for something that will change my life completely and make me think differently. So I am not confident that the user group will always come and lay out its requirements in a clear way that will let NASA do the job.

In the specific areas of the plans that have been presented for fiscal 1983, I see some rather discouraging trends. I can summarize them to say we have lost some of our interest in looking back at the Earth. There are no new space opportunities for Earth observation, with the exception of that general category of shuttle space lab experiments, which is rather weakly funded. There are no new opportunities to test things in space, so those scientists and engineers who are trying to think about better ways to measure what is going on on earth are finding a rather discouraging future. No matter how hard they think and design and test, the opportunity to go forward and produce space system does not seem to be available.

Tom Rogers has touched on some examples; I will touch on others. I am particularly distressed at our lack of future ability to observe the oceans. The oceans, as you well know, make up most of the planet. They are highly influential, not only because we operate ships on the oceans and fish in the ocean, but because the ocean influences the atmosphere in a very fundamental way.

We are beginning to see some of the interconnections, and some enticing relationships have been discovered between temperature anomalies in the ocean and weather in other parts of the Earth. It would seem important to follow up on those and see what we can do, but I do not see that the opportunity is available in the space program as now planned. This is a subject intermediate between research and applications in which we take something we already know or where we have the indication that there is something important, and transform it into a demonstration of techniques that will help us do a better job in the future.

A similar problem exists with weather forecasting. The item in the budget to improve operational systems is vanishing. The statement is made that this item will go to zero as soon as current obligations are done. Once again, that plan assumes that we are at the end, that we have a stable, steady system that needs no improvement in the coming decade. We have made lots of progress, but we are still on a steep learning curve, and other techniques, a greater variety of measurements must be, in my opinion, pursued.

I think that from synchronous orbit for example we ought to be able to measure winds over much of a hemisphere. We know now from the global weather experiment that in some parts of the world the temperature measurements that can be acquired from satellites are simply not enough to give a good starting point for a weather forecast model. Winds are required. We can probably measure winds from space, but we cannot if we do not try, and I do not see any attempts in this plan to try.

In resource observations, LANDSAT presents the same picture. There seems to be very little attempt to improve the system. It is assumed that we now have what we want, and all that is needed is to operate it and find a user community and sell the observations to them. This is at a moment when we have not even tried the thematic mapper, which will be launched later this year. When it is launched, we will find surprises in the measurements, I expect, just as we found surprises in the SEASAT mission which opened up great new possibilities, possibilities that again we are not following up. Therefore, once again it looks as if we have assumed we have

reached a logical plateau. In my opinion, we have not yet reached that point.

I am not and I cannot argue against the general allocation of funds to one part of the Government or to another. I do not study all parts of the Government. But I do believe that the reprogramming underway to diminish applications within NASA in favor of all other things in space is a mistake.

At this moment we need to watch the earth. We need to see what is going on. We need base line, global data sets of what is happening to the earth. In my written comments I make the point that this is another form of national security. Tom pointed out national security also involves pride and technical accomplishment. I try to emphasize that national security also requires we know to what extent we are messing up the world we live in, and we will not know unless we monitor the oceans, the land, the forests, and the atmosphere.

Space is the viewpoint from which we can do that best. We can only do it, though, if we have suitable global data sets in which we can detect trends early so that we can make up our minds what we want to do about them.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Firor follows:]

Statement of

JOHN W. FIROR

to the

Subcommittee on Space Science and Application,

Committee on Science and Technology

U.S. House of Representatives

2 March 1982

Mr. Chairman: You have invited me here to testify on plans of the National Aeronautics and Space Administration for FY83. The comments I will make derive from the experience I had as chairman, for three years, of the Space and Terrestrial Applications Advisory Committee and as a member of the NASA Advisory Council and my remarks will be confined to the space applications program. My term on these committees has expired and my only connection with NASA now is that several scientists at the laboratory where I work are participants in various space missions.

In reviewing the FY83 plans I have tried to select important trends or patterns to discuss with you today. I will begin with an organizational change. There was, as you know, a reorganization at NASA Headquarters in the last year and the applications group was recombined with those leading the space science effort. There is, of course, nothing sacred about a particular form of organization--a wide variety of structures will work reasonably well, but this particular shift seems to me to be a correct one. The development of space

applications needs to have a strong science base to insure that proposed applications tests and experiments are soundly based and that the experiments that are undertaken will be carefully and wisely interpreted. So placing the scientists and engineers involved in space applications in close organizational proximity to scientists and engineers exploring parts of the universe other than the earth makes good sense. I know that much has been said about the need for close contact between the space applications group and the user community, but I have never been too impressed with the ability of any operational group to see the possibility of, and ask for, major changes in its own work. Quite the contrary; the view from space is frequently too new, too different for the full implications to be understood or the full value to be assessed. Thus, in many instances the most effective procedure, in my view, for producing useful space systems is for NASA to undertake demonstration flights and projects while the potential user community is being organized, in order to work out the early operational problems, and to provide some of the information with which we can make a first appraisal of how the systems fit into various national needs and how much they would be worth if deployed. The eventual user is thus challenged in ways that speed the introduction of useful new techniques.

But beyond the Headquarters reorganization, the changes of the last year appear much less favorable to progress in space applications. Let me mention a few examples.

Some years ago the Congress, in response to speculations concerning damage to the ozone layer in the high atmosphere by various gases released by modern societies, ordered that NASA investigate relevant stratospheric science and report each two years on what progress we have made in confirming these speculations. The Upper Air Research Satellite (UARS) was, in part, designed to meet this need and was ready for approval several years ago. This mission was reviewed by several committees and received unusually warm endorsements, even by the space science committee that might have viewed this work as competitive with its own program. But despite these endorsements, despite good community cooperation and excellent mission design, despite the fact that the measurements made by this mission could well provide us with a reliable guide as to what corrective action is needed to protect the stratosphere, this mission has been delayed and delayed, and again this year the request for approval is postponed to the future.

Moving lower into the atmosphere, we all know about progress that has been achieved in the application of space observation to weather. Hurricanes can be tracked, day and night, temperatures can be measured with considerable uniformity over the globe, weather systems approaching our continent from the ocean can be observed, and in a few special circumstances winds can be observed from space. All of these achievements are contributing to a step-by-step improvement in worldwide forecast and warning capability. But nowhere in the NASA plans do I find any intent to build on these initial improvements and

push weather forecasting on towards what is possible. Space observations certainly have much more to offer, in the observation of small scale severe storms and in the observation of winds or rates of rainfall in critical areas, for example, but we will not achieve these improvements unless we try.

Another gap in the NASA plans is related to climate and climate change. The Earth Radiation Budget Experiment is, I understand, still scheduled for a 1984 launch (this date is being reviewed) and is receiving adequate support. Radiation flowing up and down through the atmosphere is, as you know, one of the important factors that must be understood before one can improve, for example, the estimates of how much a certain amount of carbon dioxide in the air will change the climate. But it is not the only factor. A weak link in the current plans is the lack of an effort to improve the knowledge of the effect of the sea or ice covered regions on the atmosphere. Several years ago the SEASAT flight made observations of several features of the oceans and ice. The mission had a short life, but even so it provided, among other things, exciting indications that one can measure from space the height of the sea to an accuracy that would allow us to map ocean currents and their variations, the state of the sea surface with enough detail to estimate the surface wind velocity over the oceans, and the sea surface temperature with sufficient reliability to discuss possible connections of anomalies in ocean temperature and the weather downwind over the land. But there is no follow-up to these possibilities in the NASA plan, no flight opportunities to observe the

world's oceans, no sustained effort on this important national and international issue.

Resource Observations present a similar picture. Landsat D will be launched this year, and, if I read the plans correctly, that is the end. No improvements are planned; no tests of other ways of observing the land surface of the world are to be undertaken.

I have listed specific weaknesses that appear to me as I study this plan. They are specific, but they suggest a pattern of a decreasing interest in observing the earth from space--a pattern I believe would be a mistake. Mr. Beggs, in presenting this budget to you emphasized that these plans were developed in light of the administration's determination to reduce federal spending. So lack of new starts is not enough to show a lack of interest in an area. But we all note that while the applications budget drops 3% or so from FY82 to FY83, NASA as a whole goes up 13%, space science goes up about 20%, the shuttle up 12%, and so on, so the pattern indeed must imply a loss of interest in the earth.

Mr. Beggs also states that the plans respond to the administration's determination to increase national security. I wonder if we are not adopting too narrow a definition of national security in only watching, as potential enemies, other countries who have tanks and guns and nuclear warheads. Clearly a strong military adversary could cut short our lives, and we must work to make the likelihood of that happening very small. But what about that other enemy of our long, healthy and happy lives--ourselves. It is well

understood today, I think, that there are enough people, globally, and these people are, on the whole, inventive and energetic enough, so that they (and I mean we) can make a mess if we are not careful. Even if we are careful many of the economic and political forces at work push for short term solutions to various problems (even though we hope that our healthy occupancy of the earth will be a long-term enterprise) and the short-term solutions may create further long-term difficulties.

So I believe we must continuously ask what are we, the human race, doing to the forests, the land, the air and the sea? How are we changing the climate, and where are we upsetting the biosphere? Space, with its global view is one of the most important ways to watch for these troubles and learn to head them off in time. Therefore, now is not the right time to reprogram our space effort away from observing the earth.

Many of the things that need to be observed will, of course, be watched with operational satellites--meteorological and Landsat, if it is continued--and possibly some military satellites. But, as I mentioned, the human race is not only numerous but inventive, and we will surely develop new ways of impacting the earth. So we need to keep experimenting with watching the earth, watching its response to what we are doing, and hopefully increasing our ability to interpret and predict so we will always have the time to avoid doing serious harm to our planet.

Mr. FLIPPO. Thank you very much for your testimony.

One of the areas that we are, of course, very interested in is the 30/20 gigahertz. Dr. Young, I think you have testified in the past before this committee about communications satellites. Perhaps I might direct this question to you.

The Air Force testified last week before this committee that they were doing a program described as a 44/20 gigahertz demonstration program, and it was implied that the technology involved in the 30/20 would be included and made available for commecialization.

I think Mr. Rogers has made the point that perhaps this is not the case because the military system is different. Could you, Dr. Rogers, or Dr. Firor elaborate upon the unique needs of a commercial system? What technologies will not be developed and made available if the Air Force proceeds and NASA does not?

Dr. YOUNG. Mr. Chairman, I would be happy to try. I would certainly want to turn the answer in part over to Mr. Rogers, who is more expert in the details of the technology. I am not an expert in the Milstar program, which is the military application program that you are describing. However, as we all understand, there are certain motivators which prompt any agency to begin experimentation with a technology—in other words, certain needs.

It is my understanding that some of the basic needs that the military has—which is the reason they are proceeding with the Milstar program—are, for example, jamproof communications at a low data rate, primarily voice. In other words, they are looking for voice transmission capability, but nonjammable. Autonomous operations of the spacecraft independent of ground control, so as to provide survivability, and also autonomous operation of the communication ground stations, again with survivability in mind. Those are all realistic goals for the DOD.

They are not, however, coincident with the major drivers or motivators for the civilian system. For example, for civilian satellites we need a high data rate. In other words, we need principally the ability to deliver full motion video, along with slow-scan video, data, and so on. Many of the uses to which existing Domsats are being put and to which the 30/20 satellite certainly would be, include the development and delivery of television pictures.

Second, we need complete control of the spacecraft from the ground, unlike what the military requires. And certainly there is a very great need—in fact, it is one of the major drivers of the system—to develop the lowest possible cost earth stations or ground technology. That would not necessarily be derivable from the military program; in fact, quite the opposite might be true.

There certainly will be transferable processes, and it would be my hope—and I would think it is already going on—that there are some discussions—probably classified—between NASA personnel and the military on the program. However, as Mr. Rogers also pointed out in his testimony, in the past, attempts to do cooperative efforts beyond the level of informal discussions and sharing of scientific knowledge have largely failed.

Therefore, for all of these reasons our board has taken the position that development, on the civilian side, of the 30/20 program is required.

Mr. ROGERS. I agree with what Dr. Young has said, Mr. Chairman, and I would like to add two or three other views as well. We must be very careful to try to describe what each side, civil and military, can and cannot do in the R. & D. area. Let me give you some sense of what is compatible and what is not.

Essentially, all of the basic research that either side would do could be shared, would be valuable to both sides. I think that maybe 90 percent of the applied research in the civil area, 80 or 90 percent would be of interest and value to the military, and conversely.

However, once you move beyond basic research and once you move beyond applied research to development, which is the stage in which you make two statements—one, "I think I know what my problem is," and, two, "I think I can put the technology together to show you that in fact I have the problem licked"—at that point the amount that is exchangeable between the civil and military sectors drops to maybe, if I had to pick a number, 10 percent. When you move beyond that to engineering and first-system tests, it is essentially zero.

The thing to keep in mind is that the amounts of money that are spent increase with each one of these steps in any system development. Therefore, we are talking about a very large ability to do things together at the basic and applied research levels but not much beyond that.

A good example, by the way, would be to take GPS/Navstar, a program which involved a very great deal of basic and applied research but that developed a system for the military to meet military operational needs, which will, because of its nature and because of other things not before the committee, will have very little civil use relative to its great potential for civil use.

As a matter of fact, it might be interesting to turn the matter around and ask a senior Defense person, given all the things on the plate of the Department of Defense these days, why they couldn't ask the civil space agency to do all their military satellite communications development work. I would guess that that would be a very short meeting.

However, I would further go on to say that anybody that starts talking about this sort of thing today should really be very well informed. I think if the committee wants to understand clearly and confidently how much the Department of Defense can do and is prepared to do, it should ask the Secretary to send senior people to testify before you. You might ask them the one question: Given their authorizations, given their appropriations, and given their responsibilities in the military domain, how much might the NASA budget be reduced seeing that they—the DOD—could handle the civil elements of satellite communications development. I think that is a good way to put it.

Thank you.

Mr. FLIPPO. Well, I think you have made some arguments for the 30/20 program. I think we are trying to understand what are the needs, what needs to be demonstrated with the 30/20. We might, if it is acceptible to you, present that question to you in writing and perhaps you could then supply us with a written response. The

question we are trying to understand is: What needs to be demonstrated that is not now being demonstrated?

I believe, Mr. Rogers, that you feel the payoff has not been adequate. Other witnesses have testified that the areas of aeronautics, computers and electronics, and communications are among the growth industries today. The implication is that these areas were developed either by the space program or the space program greatly contributed to their development. I wonder if the economic activity that is going on today in these very important areas is not a very significant payoff from the dollars invested in the space program.

[The information follows:]

8 March 1982

Mr. Flippo: What will the NASA satellite communications program do that the military program will not?

Mr. Rogers: Before preparing this answer, I discussed details of the NASA program and the military program with senior officials of NASA and the Air Force who are directly concerned with satellite communications R&D and who recently testified before your committee, and MIT's Lincoln Laboratory, where much of the military systems technology is being developed.

Mr. Chairman, NASA's advanced technology satellite communications program is the direct outgrowth of the recommendations of a committee established by the Space Applications Board to examine what should be the Federal role in R&D on satellite communications.

In developing the program, NASA followed closely the guidelines in the committee's report*. One of the most important recommendations was that the private sector providers of communications services must be involved from the very outset in planning the renewed program. This was done, and the program reflects directly the technical problems that confront the U.S. private sector users and providers of communications services, as they prepare to cope with the constraints that this country will very soon face in frequency use and in geosynchronous orbit locations, in a time of intense international competition. The program also reflects an excellent understanding of the extent of the risk that the private sector can take--without being imprudent--in committing new and as yet unproven technology to competitive operational use.

It has been suggested that military satellite communications R&D programs in the high microwave bands will provide the technology needed for civil satellite communication systems. While some of the technology needed for design of civil components could be transferable, important differences in the operational requirements of the military systems and the civil systems, and the different financial circumstances which the military and the civil commercial sectors face, drive their design in such a way that most of the technology and transmission techniques will not be transferable.

As presently conceived, one military system referred to is expected to be designed to transmit, among mobile users, about 70 secure voice-equivalent channels (or slow-scan video) at a rate of about 16 thousand bits per second. Another would transmit data over a few fixed-location wide-band trunk circuits.

* National Research Council. "The Federal Role in Research and Development on Satellite Communications." A report of the Space Applications Board's Committee on Satellite Communications. Washington, D.C.: National Academy of Sciences, 1977.

In contrast, the civil system must handle, among many separate users, the equivalent of 10,000 voice channels or 10 full-motion video channels. This requires a data rate as high as 220 million bits per second, and means that the satellite, its components and the associated ground terminals must be able to process wide-band signals. But wide-band communication uses a lot of a scarce commodity--the radio-frequency spectrum--and to avoid its profligate use the civil system must incorporate spectrum conservation technology and transmission techniques. The NASA advanced technology system achieves this by using very precisely pointed narrow-beam antennas on the spacecraft. The same frequency can be "re-used" on several beams, even though the receiving stations may be relatively close together.

The spacecraft must be able to switch the wide-band incoming signals to the transmitting antenna pointed at the appropriate ground terminal, selecting the proper transmitting frequency in the process. The antennas and the complex switch required to interconnect them, designed to handle wide-band signals in a part of the spectrum assigned for civil use but not yet being used, are well along in development under the NASA program. That each of the components will work alone can be established in tests on the ground, except perhaps for the antennas. What cannot be established without a flight test is how the components will work with each other as well as all together, as a system, and how this system will operate with other systems, such as land lines, terrestrial microwave and cable. Measurements of the characteristics of the system and its performance--and equally importantly, identification of unexpected problems that inevitably are revealed when a system incorporating so much new technology and such novel transmission techniques is first tried--are essential before the risk to the private sector of committing to a commercial system can be reduced to a prudent level.

The ability of the specialized antennas to be so accurately pointed as to hold signal spillover to the low level required for commercial communications, and the ability of the high-speed wide-band switch to work with all the other elements of the system, will not be tested in the military program.

Another element of new and unproven technology is the base-band processor, which transposes the incoming signal back to the form of the original message and imposes a special process to control errors. This technology will not be tested in the military program, either.

To reduce the uncertainty in investing in systems based on the new technology, the common carrier industry needs design, performance and cost data for the total system, as well as trials of the total system in situations simulating those that will be encountered in providing commercial services. Tests of a military system will not provide this information and experience.

The industry will share in the cost of the program--for example, by developing low-cost ground terminals that are an essential feature of a commercial system, and by conducting experiments designed to reduce the uncertainties about the performance of the total system and thus reduce the investment risk to a tolerable level.

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In further response to your question, Mr. Chairman, the following specific experiments, which have been defined by a working group* from the private-sector communications carrier industry, could not be done within the military R&D program. The experiments include:

- o experiments to demonstrate the suitability of systems, based on the new technology, for a range of commercial services, and to evaluate the compatibility of such systems with existing ground networks with which they may be integrated.

- o experiments to evaluate the ability to allocate channels dynamically to meet various baseline network traffic flow demands.

- o experiments to develop detailed precipitation attenuation statistics and mathematical models for specific continential U.S. rain zones for the specific civil transmission bands of interest which are essential for the design of commercial systems incorporating the new technology.

- o experiments to evaluate the performance of a range of adaptive rainfall attenuation compensation techniques to improve circuit and network availability (and control) for trunking and customer-site systems.

- o experiments to evaluate long-term reliability of service and performance improvements achievable with clustered earth stations (diversity) and adaptive-link techniques.

- o experiments to evaluate reliability and performance of low-cost unattended customer-site earth stations.

- o experiments to evaluate the performance and efficiency of a customer-site dynamically-allocated multiple-access system, and to evaluate network synchronization characteristics as a function of signal quality and time.

- o experiments to evaluate the effectiveness of techniques for beam acquisition, tracking and time-division multiple-access synchronization, considering satellite station-keeping accuracy and antenna-pointing accuracy, primarily with respect to the beams that scan customer sites.

- o experiments to identify and evaluate system impairments--particularly intermodulation interference--that arise as a function of beam separation and multi-channel frequency-division multiple-access loading of transponder channels.

- o experiments to validate the technology required for, and the system design of, intersatellite links carrying high data rate traffic in order to increase the flexibility and capacity-utilization of domestic and international systems.

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* including representatives from AT&T, American Satellite Co., Comsat, GTE, Hughes, ITT, RCA American, Satellite Business Systems and Western Union (many of which organizations have experience in the development of both military and civil satellite communication systems).

After satisfactory completion of the experiment period, in which both NASA and commercial-sector organizations will be involved, NASA's responsibility would end, with NASA arranging to make the products of the program available--at a reasonable cost--to the private sector for commercial use.

In summary, the military R&D program cannot be expected to demonstrate any systems capability of value to the civil commercial sector. It can be expected to demonstrate some component technology that should be of important value, but probably restricted to the area of microwave transmitters and receivers--not elements such as antennas or switches. And, of course, the military program can be expected to benefit from some NASA supported technology developments in these areas.

The NASA and military engineers and the R&D program managers are in close and useful communications regarding their present programs to insure both that each learns from the other what is of value to each program and to insure that there is no unnessary duplication.

In preparing this detailed response, Mr. Chairman, I have learned of nothing that would prompt me to modify my testimony before your Committee: "In our considered judgment, the NASA satellite communications program should proceed vigorously at an appropriation level of some $30-40 million so that it can commence technology and systems tests involving an in-orbit spacecraft at the earliest moment."

Mr. ROGERS. Mr. Chairman, I am speaking specifically about the space applications area. I am a scientist and I spent a great deal of my life doing research work, a small fraction of which, in the nature of things has turned out to have economic value. I do believe that the record is very, very clear that bright scientific minds will discover things which, in due course and with good fortune, and with the addition of a great deal of other study and assets, will produce economic benefits.

There is no question about that, no question about that at all.

In other arenas, though, Mr. Chairman—if I might introduce an expression into the science and technology world—this is called trickle down. I have a fine scientific acquaintance—I am sure John knows him, and I will not mention his name—who is a scientist in the agricultural area. He took me aside one time, and he patted me on my head, which was a little bit more easily patted than now, and he said, "You know, Tom, you have to understand about the eventual results of basic research," I describe this way: "If you want to feed the sparrows, feed the horses."

Now there is no question, and I repeat, there is no question that we have spinoff and fallout from general research and technology development activities. But in the space applications area I am talking about making conscious, thoughtful, aggressive attempts to pull out direct benefits from the space program in the relatively near term, say within a decade.

Mr. FLIPPO. Mr. Hollenbeck?

Mr. HOLLENBECK. Thank you, Mr. Chairman. Let me generally ask, if NASA this year has an extra $30 million—this is hypothetical—for applications, and of course we could assume some reasonable run-out support for the out years, what would you recommend we do with this money?

Dr. YOUNG. When you say "this year," Mr. Hollenbeck——

Mr. HOLLENBECK. For fiscal 1983.

Dr. YOUNG. In 1983?

Mr. HOLLENBECK. Yes.

Dr. YOUNG. I do not want to speak for the full Space Applications Board. I do not know that we have ever prioritized that. The two areas that we have a great concern in are the 30/20 program, and LANDSAT and the thematic mapper which Dr. Firor has already mentioned.

I guess my evaluative guess would be that if we are talking about a new start, for instance, in the communications area in about 1988, that new start could afford to wait until fiscal 1984. So we could put perhaps $15 million of that $30 million into the communications program and the rest into remote sensing.

If we try to get the new start for the 30/20 program a year earlier than that, and want to get new start dollars in in 1983, that would probably require about $20 million in the communications budget.

Mr. HOLLENBECK. I am not suspecting anything or promising anything. It is a hypothetical question.

Dr. YOUNG. If there were a $30 million pot, I would say that the communications program's requirements would be about $20 million, but I am again specifically not saying that is a priority that the Space Applications Board has. That is just a best guess based on the numbers we have.

Tom, do you want to carry on?

Mr. ROGERS. How about you, John?

Dr. FIROR. I would come at it somewhat differently, from a different background. It would seem to me that the LANDSAT data processing is essential. If we are to exploit it quickly, we should make sure that the ground station capability of dealing with the thematic mapper is brought along rather faster than is planned now.

Second, I would think that we should accelerate if at all possible the thinking and planning on ocean measurements. There is, as you undoubtedly know, a discussion within the staff of NASA of something called the TOPEX mission which has to do with topography. Accurate topography measurements let you say something about ocean currents. That mission is ripe for development and pushing it ahead would be high on my list.

Finally, I would add accelerating studies of atmospheric chemistry. We have assumed that you do chemistry by going out in the atmosphere, filling up a bottle, and measuring it, and that space had little to offer except in the stratosphere. I think that is probably a mistake, that we could push a good deal faster if we had extra funds.

Dr. YOUNG. If I may just add one thing, Mr. Hollenbeck, I think it would be very important for the committee to get quite clear the present relationship in activity between NASA and NOAA on LANDSAT, to determine where the dollars are primarily needed to accelerate that program.

Mr. HOLLENBECK. Yes, I was going to ask that question. Are there any problems with the relationship between NASA and NOAA, with respect to LANDSAT or any other satellite programs?

Mr. ROGERS. I have a view on that, Mr. Hollenbeck, and it is this. When you talk about the kind of operational arrangements that give me pause and others pause today, the problem is this: If you do not have a prompt and easy "closing of the loop" between those who are developing the technology and those who plan to provide it and use it, you introduce the chance of enormous inefficiencies in the R. & D. process.

Imagine, for instance, that the Bell Telephone Laboratories—probably one of the (if not the) premier R. & D. laboratories in the country, at least in their area—imagine that they were cut off from input, common, easy, consistent input, from their user agencies, the operating Bell companies, or from Western Electric. Now whenever I have had to testify or watch people testify from the Government if the question is asked—"Are you coordinated? Are you cooperating?"—sure you are coordinated, sure you are cooperating. Nobody commits public suicide if it can be avoided. But the fact of the matter is, I have been in a laboratory where just being down the street from another laboratory was too great a difference to allow effective R. & D. coordination.

The viewpoints in NOAA in many ways are quite different from the viewpoints in NASA, and I do think that there is a hazard here in separating those developing the technology from those trying to use the data provided in the remote sensing area. Every effort should be made to bring these people as close together as you possibly can. That is my view about that issue.

Mr. HOLLENBECK. Mr. Chairman, I yield to the gentleman from New York for a brief question.

Mr. MCGRATH. Thank you, Mr. Hollenbeck.

Nice to see you again, Mr. Rogers, Dr. Young. Last year we had a series of hearings, joint hearings with the Senate, on the applicability of LANDSAT-type technology in the commercial sector, that perhaps LANDSAT could or would be bought out by COMSAT. What is your feeling regarding that at this particular point in time?

Dr. YOUNG. Let me try very briefly, Mr. McGrath. In principle, I think that the turnover to commercial operation would be commendable and perhaps is something everybody wants. My informal understanding—and it is very informal—is that the several proposals that have been brought forward are not totally satisfactory.

One principle reason may be—and this is something our board has certainly reviewed but not discussed in detail—that to make any of those commercial turnovers viable the Government would continue to be a major customer itself. Therefore, we are really saying, "Are the dollars going to flow indirectly to support the program, or more directly within an agency?"

Mr. MCGRATH. That is the followup question. One of the problems outlined at that time was the fact that, of the potential customers, a lot of them were receiving free information at the present time and so there would be little or no market for commercialization. Colleges and States and just about everybody else who now get some of that technology or the information for nothing, would they be in the position then to pay for it, and where would the other markets come from in order to provide for a reasonable expectation on the return?

Dr. YOUNG. We did discuss the market question at some length in several of the Space Applications Board meetings. As a person somewhat outside of the Government, I was always troubled by the arguments of some of the agency people—in this case principally NOAA—that said, "Well, we have looked. There isn't a market there." My question always was, "Have you had a market study done, a professional market study?" The answer ultimately was no.

I could not take for granted that the market was not there without some scientific evidence that somebody had researched that in a businesslike way. The very fact that the French and the Japanese are coming into this country marketing their own remote sensing—the SPOT system is being marketed today by the French—would suggest to me that they feel there is a market, however underdeveloped or underaggregated it is. Therefore, I think we just simply do not have all the data in.

Mr. ROGERS. I would think, Mr. McGrath, the Congress might in this very complex discussion at least ask the following two questions: The first question is, are we really talking about a commercial takeover or are we talking about Federal subsidization. I am neither for nor against any such subsidization at present, but I think you should know very clearly here what is in mind. I think the second thing you might want to be very thoughtful about is the possibility of monopoly. I think the Government should be very thoughtful about finding itself in the position where any one organization would take over the command of all the data from the LANDSAT system.

Mr. MCGRATH. Thank you. No further questions.

Mr. FLIPPO. Mr. Lowery?

Mr. LOWERY. Thank you, Mr. Chairman.

Mr. Rogers, it is good to have you here. Looking through your testimony, I read with interest the last paragraph on the first page, and I must say your Space Applications Board is very impressive. The depth and breadth of representation from Lockheed, General Electric, TRW, A. D. Little, Union Carbide, Fairchild Space, you seem to represent a broad-based organization.

However, could you amplify on this paragraph: "We expect that the trend in space systems designed for practical use will see fewer but much more sophisticated, much larger, and much heavier spacecraft which must be placed in geosynchronous orbit. A booster able to take these payloads from the Shuttle to geosynchronous orbit will soon be essential. Our sister board, the Space Science Board, has concluded that a high-energy upper stage is essential for some future space science missions, and it seems clear to us that plans that do not provide a Centaur-like high-energy upper stage for the Shuttle will leave us seriously short." Could you amplify, please?

Mr. ROGERS. Yes, I spoke with Dr. Al Cameron, the chairman of the Space Science Board, in preparing this testimony. What I have reported here is what Al told me, that they have studied this situation and that was their considered judgment.

Now on the applications side I will give you two examples: Today there is a great deal of interest in what is called the "direct broadcast satellite" area. There are before the Federal Communications Commission requests from well more than half a dozen companies

in the United States, including the Comsat Corporation, requests to be allowed to place in orbit very powerful transmitters that would broadcast television programs to modified receivers at or near the residences.

However, even today, instead of having one spacecraft that can broadcast programs to the entire United States, the engineers find they must use three or four different spacecraft because they do not have the power in the spacecraft, they do not have the weight-carrying capacity in the spacecraft. We see the trend as one in which the more receivers that you expect to serve, the more of the system cost is in the ground end than in the space end. Therefore, you want to make the space end—of which you would have, in the best of circumstances, one satellite able to cover the entire United States—big and powerful. That means a heavy spacecraft, and that means you must have the capacity to get it up there to geosynchronous orbit.

Mr. FLIPPO. I am so sorry to interrupt the gentleman, but we have a vote now. We have 4 or 5 minutes left to catch a recorded vote on the floor, which will be followed by two additional votes. Therefore, we want to conclude this portion of our panel and tell you how very much we appreciate your testimony.

Mr. LOWERY. Thank you, Mr. Chairman.

If you choose to amplify, and I wish you would, could you please do so in a written response?

Mr. FLIPPO. We would be pleased to have that for the record. We will catch these votes and come back for the second panel. Thank you very much.

Mr. ROGERS. Thank you, Mr. Chairman.

[Material follows:]

12 March 1982

Mr. Lowery: Will you please amplify on your statement concerning the need for a high-energy upper stage?

Rogers: During the first half of the 1960s the earliest active communications satellites--AT&T's Telstar, NASA's Syncom, and DOD's IDCSP spacecraft--were small in size and low powered. They were all designed to work with a small number of relatively large surface terminals to provide a modest trunking capacity over international distances.

With the success of these early ventures, the latter half of the 1960s saw both DOD in its Tacsatcom program and NASA in its ATS-6 program initiate the second generation approach to satellite communication system design: the employment of larger, higher powered spacecraft designed to provide greater capacities to a much larger number of smaller transportable, even mobile, terminals. In time the Intelsat series of spacecraft also increased in sophistication and power, and the system capacity and number of simultaneous users that could employ them also increased sharply.

By 1980 it had become clear that very large, high powered spacecraft could provide desired services of many kinds to a rapidly growing number of simultaneous users employing smaller surface terminals.

When the number of surface terminals of whatever kind becomes sufficiently large, then the cost of the surface segment of a complete system can become greater than the space segment. This drives system design toward larger, more sophisticated and more powerful spacecraft, in order to minimize the overall system cost.

An important price to be paid for such increased spacecraft performance is that of the weight to be placed into geosynchronous orbit, and it can now be seen that our present "stable" of boosters will soon place a serious limitation on system design.

For instance, in a paper just published[1], three well known satellite communications engineers (one of them recently apppointed NASA's Associate Administrator for Space Science & Applications) point out that the weight of the Intelsat system spacecraft has grown by 25 times in fifteen years. The present V model weighs 2200 lbs., the VI model which is expected to be launched in 1986 will weigh some 4000 lbs. and the VII model now under study for launch a decade hence could weigh 6000 to 8000 lbs. Further, they point out that the advanced spacecraft now under active consideration in the NASA high microwave region satellite communications R&D program might weigh some 5500 lbs., and the use of this type of spacecraft in the lower microwave bands could call for a 7700 lb. spacecraft. These authors conclude that "... a new launch vehicle or upper stage development for the Shuttle will be required."

Further examples of heavier communications spacecraft needs can be seen in the recent submissions by several parties of requests to the Federal Communications Commission for permission to inaugurate one or more direct broadcast satellite (DBS) national television service(s). For instance, the Satellite Television Corporation subsidiary of Comsat would employ four spacecraft,

1. "Greater Message Capacity For Satellites" Burton I. Idelson, Richard B. Marsten, and Walter L. Morgan, IEEE Spectrum, March 1982, pages 56-64.

each radiating some 600 rf watts and weighing some 1400 lbs.[2], while each of the three "common carrier" spacecraft suggested by the Direct Broadcast Satellite Corporation[3] would radiate nearly 1400 rf watts and weigh 3000 lbs. Clearly, if high powered and heavier spacecraft could be placed into geosynchronous orbit economically, then the absolute service capacity could be increased, a wider choice of channels could be made available at each surface terminal without the necessity of their duplication in order to look skyward at different angles, and the number of spacecraft locations required to be assigned in the geosynchronous orbit could be minimized. The authors of the first reference simply state "It would be desirable to have as many TV channels emanating from the same orbit spot as possible....".

Another future trend in satellite communications spacecraft design is outlined in a recent paper[4] dealing with the practical possibility of inaugurating direct international broadcasting of audio programs from space as a replacement for the present surface-based shortwave ionospheric practice. This possibility is receiving particular attention by the Voice of America and Radio Free Europe/Radio Liberty as is evidenced by the testimony of officials from these organizations and the State Department before the House of Representatives last October[5]. Because of the much higher radio noise levels that would have to be overcome for satisfactory reception of audio signals in the international shortwave bands than is the case for reception of voice or television signals in the microwave portion of the spectrum, the effective radiated power required per voice channel for this type of service would have to be quite high. A spacecraft with a 150 foot diameter antenna and a radiated power of 5,000 watts per channel has been suggested[4]. While no spacecraft weight is given, such a satellite designed to today's standards, would clearly weigh many thousands of pounds.

Two final observations: (a) In reponse to this trend, NASA and aerospace industry engineers are giving careful consideration to the use of so-called space platforms of various kinds to be located in geostationary orbit which would be used to accomodate many and different communications (and other) payloads. A weight of over 10,000 lbs. has been suggested for such a platform[1]; (b) the European space community is reported[6] to have decided during its late January 1982 meeting to proceed with the development of "... a new Ariane launcher--Ariane 4. It is to be powerful enough to boost satellites of 4.3 metric tons (9,479 lbs.) mass into geosynchronous orbit...twice the mass [capability of] the present Ariane." And the article goes on to observe that "...ESA members...are well positioned to challenge the U.S. space Shuttle."

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2. See, for instance, STC's brochure "Satellite to Home Pay Television".

3. See their application to the Federal Communications Commission dated July 16, 1981.

4. "Use of the 26-MHz Band for Satellite Broadcasting" G.J. Phillips and P. Knight, EBU Review-Technical Part, August 1978, pp. 173-178.

5. International Shortwave Broadcasting and Direct Broadcast Satellites: Voice of America, Radio Free Europe/Radio Liberty, Radio Marti", 20th Report of the [House] Committee on Government Operations, December 11, 1981.

6. Robert C. Cowan in the Christian Science Monitor, March 8, 1982, p. 1.

[Recess taken.]

Mrs. BOUQUARD [acting chairman]. The subcommittee will come to order. We welcome our second panel today, consisting of witnesses from outside the aerospace areas. They represent companies who have seen the benefits that space can offer and have moved to take advantage of these benefits. Perhaps they can help us determine, among other things, how far NASA should carry a technology before turning it over to the private sector.

Our first witness will be Dr. George Braun, vice president of technical affairs for Johnson and Johnson. The second witness will be Dr. Gordon Millar, who is vice president, engineering, Deere and Co., accompanied by Mr. James Graham, who is senior research associate at Deere and Co.

Gentlemen, welcome. You may proceed with your testimony, Dr. Braun.

STATEMENT OF DR. GEORGE BRAUN, VICE PRESIDENT, TECHNICAL AFFAIRS, JOHNSON & JOHNSON

Dr. BRAUN. Thank you.

With the committee's permission, I would like to read about a 6-minute prepared statement.

Mrs. BOUQUARD. Without objection, and your statement will be made a part of the record. Please proceed.

Dr. BRAUN. It is a pleasure to be here and to present our views on the opportunities that space may offer to one segment of American industry. As you know, Johnson and Johnson is a major provider of health care products worldwide. It is as a result of the interests of one of our major affiliated companies involved in the research and development of pharmaceutical products, namely Ortho Pharmaceutical Corp., that we have become involved in exploring the feasibility of materials processing in space.

You are aware that NASA has entered into a joint endeavor agreement with McDonnell Douglas to develop and demonstrate the technology of continuous flow electrophoresis in the low gravity environment of space, and its applicability to the production of pharmaceutical products. As you know, Johnson and Johnson is working with McDonnell Douglas toward researching potential products. This effort has been ongoing at McDonnell Douglas since 1977 and at Johnson and Johnson since shortly thereafter.

As this committee knows, the unique characteristic that space provides is a gravity-free environment, a condition which cannot be reproduced on Earth. This essentially gravity-free or more properly microgravity environment provides an opportunity to study the effect of weightlessness on the isolation and purification of certain types of complex macromolecules.

There are a number of these macromolecules that possess great biological significance but which at least to date have not been or may not be capable of being isolated in sufficient quantity, or for that matter in sufficient purity, to allow the necessary studies to be performed which would allow a determination of their usefulness as potential therapeutic agents. These molecules generally are highly active, requiring very small quantities, perhaps at the mi-

crogram level, and thus would lend themselves to the type of processing allowable in space.

The investment made by both companies in this research is based on the belief that the benefits of processing in the low gravity environment will outweigh the increased costs of space versus terrestrial operations. Key to this belief is the assumption that there will be the required access to the space environment. At the present, this effort is effectively utilizing the space transportation system, STS, with the flight of the single electrophoresis chamber scheduled on the shuttle orbiter middeck in July of this year on STS–4; five subsequent reflights through 1984, and two flights of a scaled-up, automated facilitiy in the shuttle payload bay in 1985 and in 1986. These flights would supply sufficient amounts of test materials to prove the process and provide materials for clinical trials.

It is at the point of initiating clinical trials that a substantial commitment of resources, measured in time, people, and dollars, will have to be made in order to prove the safety and effectiveness of these molecules. This commitment will be in terms of tens of millions of dollars over 5, perhaps 10 years. Assuming favorable results, it will then become necessary to provide the amount of material and the continuity of operation that could ultimately supply the necessary quantities of purified product for the treatment of the general patient population.

Adequate supplies of test substance could be furnished initially by multiple sorties on the Shuttle. However, the frequency of such flights necessary for continuing supply of large quantities would tax the capabilitiy of the STS and diminish its ability to support other uses. If this and other applications of space industrialization are to fulfill their potential promise, we believe long-term, on-orbit facilities will be required. Such host facilities would provide for the needs of multiple space industrialization payloads. At the time we initiated our program, long-term, on-orbit facilities were part of NASA's long-range planning, and our decision to proceed was based in part on the existence of those plans. It is our hope that such facilities will be available not only for our use but for that of others who may benefit from this unique environment.

In your invitation to testify before the subcommittee, the question was raised regarding the need for flexibility in product decisionmaking, particularly as it applies to terminating projects at the completion of the research stage. Let me say that in general, in projects of the type we are discussing and which are heavily research dependent, flexibility is an extremely important element. The willingness and ability to terminate a project based on adequate but negative scientific data is a necessary ingredient to the research process.

It is equally important, however, to have the same willingness and ability to allow the experimental results to guide subsequent direction—through the demonstration stage if so indicated. Simply stated, there is little point in establishing feasibility through expensive and painstaking research unless there also exists the accompanying opportunity to harvest the fruits of that effort.

Thank you.

[An additional statement of Dr. Braun follows:]

Johnson & Johnson International
NEW BRUNSWICK, NEW JERSEY, U.S.A.

April 1, 1982

The Honorable Ronnie G. Flippo
Chairman, Subcommittee on
Space Science and Applications
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Flippo:

I am pleased to have the opportunity to expand on my comments made before your Subcommittee on Tuesday, March 2, 1982, and to deal more directly with some specific questions that you have posed.

Your statement that the strength of our nation would seem to lie in the entrepreneurial spirit of the private sector reflects both my own views as well as, I believe, those of a substantial segment of American industry. It is that entrepreneurial spirit that has helped to bring our nation one of the highest standards of living while maintaining an expression of human freedom that is without parallel in the world today. We have accomplished this while remaining competitive in world markets; e.g., we represent substantially less than 10% of the world's population but have provided, up through the decade of the 60's, one-third of the world's electric power, one-fifth of its steel and one-third of its automobiles. This has been the result of two factors - superior technology and high productivity. Unfortunately in recent years, we have experienced a decline in our competitive position worldwide and as a result we must address ourselves to improvement in both of these areas, i.e. technology and productivity, if we are to regain our preeminent posture in the world.

With regard to space industrialization, that entrepreneurial spirit can be vitalized by the further encouragement of joint endeavors between NASA and the private sector. The opportunity of industry to commercialize on technology developed as a result of space exploration provides a major incentive for industry to invest and to share in some of the risks at an early date. In the space program, as in other activities, we must continue to attempt to encourage investment in research, protect the effective patent life of products and create, wherever possible an environment that rewards risk taking.

You ask what role should the Federal government play (i.e., to protect the environment, national security, international obligations, etc.). All of these issues are broad in scope and clearly involve policy decisions of national importance and thus require government to take an active and leadership role. In addressing environmental issues two concerns have risen to the top; one is the public's increasing concern for a clean environment and its tendency to push for "zero risk". The government must be sensitive, in its efforts to satisfy this public need, not to unduly stifle initiative and innovation with excessive or disproportionate benefit/risk assessments - to the extent to which we eliminate risks, we also tend to increase the cost of goods and decrease the availability of products and services. Standards for environmental protection should be established in concert with industry as well as the public sector since it is industry that often has the expertise and the knowledge to: a) know what is feasible, b) help in the cost/benefit assessments and c) evaluate the impact of these standards on productivity.

When dealing with issues such as national security, international obligations and other far-reaching and complex responsibilities, governmental policies must be based on an insight and understanding of the problems. The public in varying degrees is expressing concern about our ability to control our environment, to protect our national resources while remaining productive and competitive, to eliminate proverty, to avoid nuclear confrontation at all costs and to live in peace, if possible, etc. Government must enter into a dialogue with its citizens, understand their concern and take steps to ensure, in its efforts to achieve solutions to these social problems, that freedom is protected.

Regarding your question on the effective leveraging of NASA'S research and development endeavors vis-a-vis the private sector, it is my belief that a strong industrial liaison program would be in order. I understand that NASA is working closely with industry and industry groups such as the American Institute of Aeronautics and Astronautics (AIAA) towards this end. I encourage this effort to continue and if possible, perhaps receive greater emphasis.

In another vein, it is also helpful that when certain facilities involved in expensive technology are developed they be made available to industry: an historical example is the wind-tunnel facility which has enabled the development of most, if not all, modern high-performance aircraft. Similarly, the availability of a functioning orbiting laboratory should be attractive to many industries in conducting experiments and

developing products where a micro-gravity environment may be desirable. There is little doubt that more effective liaison, communication and availability of certain types of facilities would better enable the private sector to identify, evaluate and exploit for commercial purposes the knowledge and skills developed as a result of NASA'S research and development efforts.

Lastly, you ask what other Federal agencies could do to encourage the private sector. Probably the single most important change (and I believe this may be occurring in some areas) would be for our regulatory agencies to depart from what traditionally has been largely an adversarial role. All too frequently Federal agencies involved in regulation regard their mandate as a strict policing function and often shy away from any positive contributions on how to best solve the problem. They often fail to participate in developing regulations which achieve the objective but which have minimal impact on the economy or on incentives to research-based industries.

More recently the general trend of the Federal government, in many of its agencies, to address such issues as excessive and/or inappropriate regulations, effective patent life, more favorable tax credits and incentives to encourage investment in R&D, etc., should be helpful in encouraging the private sector to enter into more risk-taking ventures. As stated previously, it is the private sector that has the skills and capability to translate the fundamental knowledge and discoveries stemming from government (and academic) research into useful products and services. Increasing government support of this role can only lead to an encouragement of an intrepreneurial spirit and increased productivity on the part of American industry.

Sincerely,

George A. Braun
Vice President, Technical Affairs

GAB:lt

Mrs. BOUQUARD. Thank you very much, Dr. Braun.
Dr. Millar, would you proceed with your testimony please?

STATEMENT OF DR. GORDON H. MILLAR, VICE PRESIDENT, ENGINEERING, DEERE & CO.; ACCOMPANIED BY JAMES GRAHAM, SENIOR RESEARCH ASSOCIATE

Dr. MILLAR. Madam Chairman, with your permission I will read the prepared statement, if that suits your purpose.

Mrs. BOUQUARD. Without objection. Proceed as you wish.

Dr. MILLAR. I would like to first say we are very pleased to be here to contribute to your committee's work. I would like to tell you a little bit about our company, how we became involved with NASA, what role we expect NASA can play, and how—in what may seem to be an indirect way—how the benefits of the enormous resource in science and technology which you have developed can be applied to the very practical world in which we live as an industrial manufacturer.

Deere & Co. is one of the world's leading manufacturers of farm equipment, industrial equipment, earthmoving and forestry equipment. Our fiscal sales are a little over $5 billion, ranking us about 60th in the Fortune 500 listing. Our research budget in 1981 was about $240 million, and we think this puts us about 25th in U.S. industry as far as the money we spend in our engineering research activities.

Historically we have not participated in contracts with the Government except in times of national emergency. As a result, we have had infrequent technical contact with Government research agencies. However, in 1979 we were invited to attend the American Institute of Astronautics and Aeronautics NASA Corporate Associate Program, whose purpose is to promote utilization of space technology.

Our first meetings dealt with the Space Shuttle. However, as we visited more NASA research centers and became familiar with their capabilities, we realized that they represented an important, untapped resource of advanced technology for our company. Many of the technologies we need to design and manufacture our equipment are the same as those used at NASA.

Since then, our attention has focused on the application of NASA-developed technology within Deere. Since that time, we have had a number of direct contacts with NASA personnel that have proven to be very beneficial. Today I would like to review some of these experiences with you, give you our view of the business and technological opportunities NASA presents to the nonaerospace industry, and discuss some areas of concern for the future.

During the last 3 years, Deere & Co. has made a concerted effort to become familiar with your technology and to identify areas which may contribute to our products, our engineering operations, or our manufacturing processes. We have worked with NASA in a number of different ways in the process.

First, Deere scientists and engineers have made several trips to various NASA research centers through the AIAA Corporate Associate Program. These visits have given us an excellent overview of

NASA research activities and have allowed us to develop important professional relationships with a number of NASA scientists.

Second, more than 20 Deere scientific specialists have visited their counterparts at NASA to discuss mutual and technical problems. We have reviewed diesel engines, metals technologies, ceramic applications, and work on portable fuels with personnel from the Lewis Research Center. We have discussed composite materials, nondestructive testing, and adhesive bonding with experts from Langley.

Personnel from the Jet Propulsion Laboratory have met with us to review robotics and computer vision guidance systems for welding, solar energy conversion, and computer software developments. We have also had a significant exchange of information with scientists from NASA headquarters on energy conversion.

Third, on five occasions NASA scientists have presented seminars at our technical research center. Representatives from Marshall Space Flight Center made a presentation on the materials processing in space program. Joe Heyman of Langley reviewed nondestructive testing techniques, and Marv Herschberg of Lewis described work on high-temperature fatigue. Ed Bangs of the Illinois Institute of Technology manufacturing applications team reviewed NASA work on manufacturing processes. We have also received a presentation from the Aerospace Research Application Center located in Indianapolis.

As a result of the contact with the materials processing in space program, we have entered into a joint research project with NASA to investigate the solidification of cast iron under zero gravity. This project will help us to better understand cast iron metallurgy. Adopting this understanding to current foundry operating practices should contribute to the production of superior cast iron at the lowest possible cost.

This project brought about the first technical exchange agreement between NASA and a private, nonaerospace industry. The agreement signed in July 1981 has provided a good basis for professional and scientific exchange by scientists of our two organizations. There have been two visits from Marshall to Deere, and seven visits of Deere personnel to Marshall Space Flight Center.

We have used the AIAA technology transfer program to help identify NASA personnel with the special expertise related to specific Deere design and manufacturing applications. We have contracted for 20 days of consulting time under this program.

A top-level NASA project team has visited Deere & Co. to discuss productivity improvement. Top Deere & Co. executives met with this group to review the philosophy, procedures, and planning which have enabled John Deere to achieve the high productivity and low operating costs for which our corporation is known. We hope this input will contribute to the productivity improvement program being developed by NASA.

As you know, the development of our national space program has required an enormous amount of basic research and development. This work has been done by NASA personnel, by universities, and by contract to industrial organizations. Aerospace corporations, by virtue of their constant, ongoing contact with NASA, have developed many commercial applications of this space technology. Other

corporations such as ours have had much less contact with NASA. As a result, we have not taken full advantage of this resource.

It is not difficult to identify numerous examples of NASA-developed technology that are potentially useful to nonaerospace industries. At Deere, for example, we are particularly interested in areas such as energy conversion, materials research, computer graphics, human factors, and advanced computer software. We have already used NASA computer programs such as NASTRAN and FEATS to assist in product design analysis. We have been surprised to learn how much research at NASA may have broad industrial applications and how little most of the private sector knows about this work.

American industry, as a rule, focuses research efforts and funding on short-term applied research directed toward product or process development where the market potential can be identified. They look to other sources for basic research. A great deal of this has been provided by Government-funded programs such as NASA.

We believe it is essential for Government to continue funding selected basic research which offers opportunities for broad application and development across the full range of American corporations. Because of limited applications within a single company, high risk, and tremendous cost, it is often impossible for any one company to fund most basic research projects over the long term.

Each Government laboratory is required to use a percentage of its budget for technology transfer. Unfortunately, this activity usually receives low priority even though technology transfer is clearly beneficial for both Government and industry. The value and potential of the technology residing within NASA is obvious. It must be recognized, however, that this wealth of technology will not be assimilated by private industry solely by virtue of its sheer quality or need.

Just as within the corporate structure, technology transfer between NASA and industry requires a special effort by both parties. The proposed funding level for fiscal 1983 for this purpose is a significant reduction and may seriously impair the transfer of technology to nonaerospace corporations. This seems inconsistent with the important steps Congress took just last year to stimulate increased research and development through the use of various credits. We believe the potential benefits to the whole of American industry merit greater support for this purpose.

NASA has, of course, taken a number of steps to aid in the technology transfer process. The establishment of a technology utilization officer at each NASA center, and publications such as "Spin-Off" and "Tech Briefs" are helpful examples. The distribution of computer software through COSMIC is also a very worthwhile program. It has enabled many universities and companies, including ours, to enhance their computer capabilities substantially.

We recognize that visits by Deere engineers to NASA centers have been of great benefit to us. However, we are concerned that as a number of companies move into this activity, NASA may be flooded with requests and consume an inordinate amount of their time. This has resulted in our being hesitant to contact NASA and has limited our exploration of all the fruitful areas we visualize.

New protocols or procedures need to be implemented to establish guidelines for such interaction. These new relationships should be similar to the normal industrial practice and avoid, as much as possible, complexity.

The NASA research centers contain numerous facilities, some of them one-of-a-kind, which could be very useful for industrial research. Temporary assignments of industry people at these laboratories would promote cost-effective research projects which may not be possible otherwise.

Technical societies have established excellent, cost-effective methods for technology exchange and distribution. Only a few technical societies have benefited from NASA participation. Increased participation of NASA scientists could prove to be a very cost-effective method for transferring technology.

We have seen technology development at some research centers which parallel programs at our company and are no further advanced. It is obvious both groups were developing the technology at the same time. If we had known about each other's interest and found a means of working together, both organizations would have been more productive.

Interaction with NASA has been fruitful and stimulating for Deere, and I trust has also been beneficial for NASA. As we are pushed for greater technical depth in Deere, in our industry, in our productive capability in North America, and to meet the same challenge as a nation, I feel continued interaction will be beneficial to meeting this objective. A new dialog and partnership between Government and industry must be forged if we are going to create a new framework of cooperation to meet the challenge of international competition, reestablish a flourishing economy, and maintain the United States as the industrial leader of the world.

[Answer to questions asked of Dr. Millar follow:]

DEERE & COMPANY

JOHN DEERE ROAD MOLINE, ILLINOIS 61265

GORDON H. MILLAR
Vice President

28 April 1982

The Honorable Ronnie G. Flippo
Chairman, Subcommittee on Space Science & Applications
Committee on Science and Technology
U. S. House of Representatives
Suite 2321, Rayburn House Office Building
Washington, D. C. 20515

Dear Congressman Flippo:

Let me first express my appreciation for the opportunity to appear before your committee. Although Deere & Company is not normally associated with space science activities, we believe future developments from this research can have an important impact on our business by providing an important engineering resource. The questions posed in your letter of March 8, 1982, to Dr. Braun and myself are quite broad and far reaching. I have tried to somewhat limit my comments from the corporate view of Deere & Company in how these Federal activities may affect the kind of business we conduct and the production and worldwide sales of farm and industrial equipment.

Replies to the questions presented are:

a. The Federal government must continue to provide the leading edge in funding of basic research. It can be expected that much of the benefits and new discoveries will be unexpected which is contrary to normal business investment practice for American industry. To evaluate the business merit of new opportunities and to attract business investment, new technology will have to have established a reasonable probability of success and we must be able to identify the potential market. This will mean any new process, material, or development will have to be taken to the stage of a pilot operation by the government to establish feasibility of these new efforts.

Overall basic research is heavily funded and conducted by the Federal government and a quick change in this practice is unlikely. Great benefits can accrue from government funding of basic research because of the multiplicity of applications which can develop in many companies and even industries, whereas, research funded by individual corporations must pay off within just one company.

The space program must establish long-term plans for industry to evaluate and must be stable. The capabilities of the Space Program must be promoted to industry or industry will not pick up the opportunities based just on the pure need or benefits--the case must be taken to the marketplace. Early input from industry will enhance the probability that the space program will serve the interest of industry.

New ideas continue to be difficult to promote in the legalistic environment of government/industry relations--little entrepreneurial spirit can be fostered in an adverserial atmosphere. We must forge a new partnership between government-industry-academia based on a cooperative spirit. In order to fund these high-risk, large-investment ventures, there must be greater sharing and involvement among corporations.

b. Safety and environmental regulations should have greater scientific input to insure they are sound and feasible and the costs and benefits can be estimated with reasonable confidence.

Laws and regulations should be general rather than specific, that is performance oriented, not design directed, to allow for creative scientists and engineers to solve problems. Because wealth or profit is seldom created by the added cost of environmental investment, greater cooperation and latitude for joint funding and development programs between corporations should be allowed.

The multinational corporation needs fair and equal treatment in every marketplace if investment decisions are to be made with business facts as the dominant factor. Government must establish a known, stable environment of uniform and fair policies that promotes transfer of wealth or business movement openly and equally among all nations.

This can best be achieved by promoting free exchange and multilateral investment rather than restrictions which allow some to seek favorable positions at the expense of others.

Certain industries are essential to a strong nation and to the defense of the country. Some of these may not be normally associated with defense. The machine tool industry, for example, could be very critical to the defense program. However, its capabilities in the U. S. have declined relative to other nations. Imports now capture 36 percent of the total domestic machine tool market. All critical industries must be identified and suitable steps taken to assure their needed strength in our economy. A National Research Council report is being prepared to define what is needed to achieve this.

c. NASA can and possibly should continue to provide the leading edge of new scientific developments. It must make a significant effort to spin off or move this new technology into the non-aerospace industry to multiply the many benefits of these new engineering developments. It will have to provide the funding of new ideas until the market potential and investment requirements can be identified. We must remember Columbus did not return as a hero even though he certainly made a great discovery. Today's space adventure has the same potential for greatness and similar perils. We must keep an open mind and follow all avenues before us to pursue new discoveries to benefit mankind. We cannot look only where we anticipate and ignore the many surprising observations which will certainly come before us. This, however, is not the normal practice of business where we must attach a profit measure, usually short term such as five years, to our investment plans.

d. Most Federal agencies have unique laboratory facilities, sometimes one-of-a-kind, which cannot cost effectively be duplicated by industry. Many times because of their narrow and specific purpose there exist large portions of time when they are not fully utilized. They represent a significant national resource to these agencies, but also could be very valuable to industry for specific, limited subject research. A very attractive program would be to open these facilities to industrial researchers on an as-cost basis for temporary assignment to conduct industrially funded programs at the government location. This would be similar to aerospace industrial use of Federally constructed wind tunnels.

A significant reservior of technology which is not critical or indigenous to national security but is only available to defense contractors may contribute far more to our security through improved industrial capability. Technology such as robotics, electronics, and machine tools could be quite valuable to the heavy machinery industry and all manufacturing.

Today, many government scientists are not full and active members of American technical society activities. The interplay between scientists at these committee meetings, the publication of technical papers, and the development of standards and new procedures or techniques could benefit greatly from government scientist participation. This would create a very attractive vehicle for transferring technology from the government sector to industry. The transfer of government developed technology must be an ongoing effort if industry is to realize the full benefit and develop commercial application of these new scientific discoveries.

In clo ing let me repeat that I am appreciative of the opportunity to provide you with information to help guide your efforts in science and space technology. It is enormously important that the United States maintain its technological vitality and your efforts in this direction are to be applauded.

Best regards,

Gordon H. Millar
Vice President, Engineering
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Mrs. BOUQUARD. Thank you very much, Dr. Millar, for your testimony.

I think the questions here are the same questions that I hear as I chair my Subcommittee on Energy Research and Production. The administration is saying, "Let the private sector do it," and we see that in so many areas this is not possible. The free enterprise system is not basically fostered when the incentives are simply not there to proceed with a given technology. We certainly do want your guidance as to how we should lead NASA through this period, so I have appreciated your testimony and appreciated your being with us today.

The strength of our Nation seems to lie in the entrepreneurial spirit of our private sector. How can we best let that spirit bloom with respect to space industrialization? Would you like to answer that question, Dr. Braun?

Dr. BRAUN. Well, yes. As you realize, we are somewhat, at least once removed from direct contacts with NASA. We have primarily worked through the McDonnell Douglas Corp., who have had the direct contacts with the organization.

Having said that, I do believe that the programs that we have embarked on are extremely important ones. They could not be done without the types of things NASA is doing and that NASA plans to continue to do. I cannot envision by any stretch of the imagination, private industry taking the type of leadership and doing the types of things that NASA has done to date. I just cannot imagine that being done. I think we are just very dependent on that type of effort.

Mrs. BOUQUARD. I would like the opinion of all of you on this question: What role do you think the Federal Government should play in protecting the environment, national security, or international obligations? For instance, I was back in my district this past weekend holding town hall meetings. Half the people there were asking for Federal help; the other half of the people were asking for less Federal intervention. I said, "Look, you know you cannot have it both ways." I do think we need to have more of a basic consensus as to where the Federal Government should leave off and where there are areas of work and cooperation.

Dr. MILLAR. Well, if I can take a shot at answering that question, we are relatively new to this kind of a relationship, having been involved with NASA only in the past 4 or 5 years, less than that, actually. However, it strikes us, maybe in a naive way, that there is an enormous amount of information, of basic research, of technology available in NASA and probably in other parts of the Government that we are not familiar with, that we simply have to develop a way to have access to.

Our very business, and the productivity of our industry in North America, and the competitiveness of our manufacturing enterprise in a global sense depends not only on shuffling dollars or on advertising but on the fundamental technology with which we work. That can only be enhanced and strengthened by injecting substantial amounts of science.

Now the heart of the scientific effort in a pragmatic kind of science—I am not talking about the science of human relations or the other sciences that those of us in industry look upon as a little

more lightly structured but what we like to call the hard sciences, the hard disciplines of metallurgy, engineering, thermodynamics, computer sciences—those are really the heart of manufacturing in North America, and we have not done as well as some of our offshore competitors.

Therefore, forging the kind of relationship that we envision between NASA and ourselves is going to be enormously important, not only for NASA, not only for us as a company, but as a nation. Now the real question of how we specifically do this is very difficult because there has not been historically an open and free relationship.

However, if somehow the administrators, somehow the Government, somehow people in our own industry could open up that relationship so there is a freer exchange, and let us decide how to use the science to become productive, and allow NASA and the enormous technical depth that you have create the science, then I think you can forge a very powerful, useful relationship that should go a long way to helping our industrial competitiveness in the global markets. That is basically our position at Deere.

Mrs. BOUQUARD. I understand you feel, and I share your philosophy, that the private sector puts their money where they know there is a buyer for the product in the marketplace. In addition, you feel that NASA has a role and industry has a role, but is this going to happen naturally; is the private sector going to pick projects up?

Dr. MILLAR. I guess to say, is it going to happen naturally, may overstate the case. I think that making it visible will encourage it happening. One of the reasons we were not involved with NASA earlier is that we just simply were uninformed.

Therefore, I think one of the roles, one of the activities NASA can embark on is simply a visibility program. The information officers that you have established at the various research centers are a step in that direction.

Beyond that, I cannot recommend any specific programs because the instant you do, somebody says, "Where are you going to get the money?" However, you realize that so far, what we have done with NASA, as far as our own activity and as far as the cost to NASA, has been really very minimal. It has been minimal cost and yet it has enormous leverage as far as making our products more competitive in a global sense.

There is just an awful lot available that we have not even used yet, and so I would not worry quite so much about what we are going to do in new science until we have really been able to digest what already exists. That is an information program, and an information program, it seems to me, would be an enormously effective use of whatever dollars are available.

Without getting out of the periphery where we have been assigned, if someone asked me where I think you ought to put another $30 million, which you asked the previous panel, I would put it in information transfer. From our point of view, that is where I would put the $30 million.

Mrs. BOUQUARD. Dr. Braun, would you care to comment? What role do you really think the Federal Government should have in

protecting the environment, and in national security, and in our international obligations, from your vantage point?

Dr. BRAUN. Well, I think that it really does not need saying. I think the Government must play a leading role in all of these areas. I just do not see how else it can be done. I do not say that they have to play the only role but I think Government must be on the cutting edge of science and technology. To do otherwise, to me is inconceivable.

I think the questions come down, then, to just what areas should be emphasized, what are the priorities, and what should the relationship be with the private sector. I think that will depend on specific programs. I agree with Dr. Millar, I think if we know more about what it is that NASA, for example—which is only one small example and one small part of your question—is doing, I think the applications will probably be more than industry could handle, even at this point in time, but we are not aware in many cases of what is going on. We have been very fortunate through the nexus of a McDonnell Douglas to have one little window into that enormous program.

Mrs. BOUQUARD. What do you gentlemen feel the Congress should do in terms of legislation to promote the activities that you propose to continue?

Dr. MILLAR. I guess I am not really in a good position to answer that question because I do not know precisely that we need any legislation. What we really need is simply some commitment, some mutual commitment. I really believe—and I am not a legislator and I am not deeply involved in the Government—but I really question if the answer, at least from our point of view, is legislation. I think the answer might well be in stimulation, in management, in operations, how NASA conducts itself in its relationships. We have no feeling at all that there is legislation standing in our way.

Jim, you might want to support that or refute it but we are not in any legislative problem.

Mrs. BOUQUARD. Has the AIAA been helpful to you gentlemen?

Mr. GRAHAM. Yes, it has been very helpful because it opened our eyes to what was available in the NASA research centers, not products that we could use but the knowledge about certain sciences that could be applied to our products, which are substantially different.

Mrs. BOUQUARD. For the potential of your participation in the space program, knowledge is important, is that correct?

Mr. GRAHAM. Right, and the adopting of some knowledge, say, on adhesives. We had a problem with an adhesive, and through the AIAA program we were put in contact with an expert at Langley on adhesives. He was very familiar with what we were trying to do, the design, the kind of adhesive to use. It was extremely helpful. This was a very direct application but there are a lot of other things about the knowledge of materials, for instance, that can be applied on our products just as well as it can on the NASA space programs.

Mrs. BOUQUARD. Do you gentlemen think that the AIAA role should be expanded, and if so, in what direction?

Mr. GRAHAM. I think there are some very good opportunities for the AIAA program to be expanded and to bring together even closer, experts from the companies and NASA. In the past programs it has been a very broad overview of what is available at a given NASA research center.

One of the things that I would like to see done is to have more specific technology so that we can send our expert in a given field to a NASA center and let him spend a whole day on one subject. I think this would be very useful to us and it would also reduce the amount of time, I think, that would be required by NASA. If we go one company at a time it is going to take an awful long time to cover the major industries in this country but as a group they could be covered very well.

Mrs. BOUQUARD. I have a question that I want Dr. Millar and Dr. Braun both to answer for me: In your opinion, will materials processing in space lead mainly to industrial processing or production in space, or mainly to applied research on processes to be used on Earth?

Dr. MILLAR. I am not totally sure I understand the language but let me answer the question.

Mrs. BOUQUARD. Do you and Dr. Braun agree about the future use of materials processing in space and on the Earth?

Dr. MILLAR. Where it helps us, of course, is in the applied research mode. We do not envision, for example, producing productive quantities of material in a zero or minimum gravity environment. The role that it plays for us right now is to better understand the structure of metallurgy so that we can, then, transfer that to an earthbound environment and benefit from the research efforts in that mode.

Mrs. BOUQUARD. Dr. Braun?

Dr. BRAUN. I really see it doing both. The materials processing endeavor certainly can very realistically yield a way of processing materials that we cannot process on Earth—at least, that is the potential—thereby giving us access to potential therapeutic agents that we may not be able to develop on Earth. However, it may well be that the knowledge we gain from space processing may allow us ultimately to bring that back onto Earth and do it where we could not have done it before, so I see the knowledge gained there could be very, very helpful. I could see it going either way, and I think probably in some areas it will go both ways: We will find better ways to do it and maybe bring it back onto Earth.

Mrs. BOUQUARD. Therefore, you feel that there are near-term answers and far-term answers?

Dr. BRAUN. Exactly, I see both in most programs.

Mrs. BOUQUARD. Would you care to comment Dr. Millar?

Dr. MILLAR. No, I can support that. The only reason we take a little different point of view is because of just the gigantic amount of material we use. Envisioning that being fabricated in any way, short term or long term, in a space environment really stretches the credibility of that concept but clearly the science is transferable. What we learn in space, it is our task, then, to put that to work in an earthbound environment.

We are very pleased with our relationship so far in that specific mode. We will be flying samples this summer. We have been on flights already and we look forward to a continued association.

Mrs. BOUQUARD. Thank you, gentlemen. Do you have any further comments to make?

Dr. BRAUN. Just as a final statement, I think the program we are embarked upon is an important one. I would certainly like to see it continue and we are very hopeful for a positive outcome.

Dr. MILLAR. We are very pleased to be here. I had a most unusual experience just a week ago Friday when eight key people visited our organization to learn about productivity. They said, "Well, we don't know much about this" and they were very receptive. However, I have to tell you that within our company and the part of the world where we live, we are very proud of NASA and we are very, very pleased with our association.

Thank you, gentlemen, very much.

Mrs. BOUQUARD. If there are no further comments, we will adjourn until 10 a.m. tomorrow.

[Whereupon, at 4:07 p.m., the subcommittee recessed, to reconvene at 10 a.m. on Wednesday, March 3, 1982.]

1983 NOAA LANDSAT AUTHORIZATION

WEDNESDAY, MARCH 3, 1982

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10:14 a.m., in room 2325, Rayburn House Office Building, Hon. Ronnie Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Brown, Nelson, Hollenbeck, Lowery, and McGrath.

Mr. FLIPPO. The subcommittee will come to order. Today's hearing will focus on the use of satellites for weather observation and for finding resources. First, we will have testimony from Dr. Anthony Calio, Deputy Administrator of NOAA, who will describe NOAA's budget request for its satellite programs with particular emphasis on the policy issues surrounding the LANDSAT program.

Following Dr. Calio we will have a statement from Dr. Ronald Cormick representing the Geosat Committee. Dr. Cormick is an employee of CONOCO, and the Geosat Committee is composed of industries interested in using remote-sensing techniques—such as LANDSAT—for geological purposes; for example, to explore for oil.

Since we have much to cover, let us welcome Dr. Calio who has been before the committee in other capacities. Let us now welcome him for his first visit in this capacity.

We are pleased to have you, and we would be delighted to receive your statement in full for the record. Please feel free to summarize, and please introduce those gentlemen at the table with you.

STATEMENT OF DR. ANTHONY CALIO, DEPUTY ADMINISTRATOR, NOAA, ACCOMPANIED BY DR. JOHN M. McELROY, ASSISTANT ADMINISTRATOR FOR SATELLITES, NOAA

Dr. CALIO. Thank you very much, Mr. Chairman. It is indeed an honor for me to be back before this subcommittee in my new capacity as a representative of the Department of Commerce's National Oceanic and Atmospheric Administration. I look forward to a continuation of the fine relationship I experienced when testifying as a representative of NASA. It is indeed an honor and a privilege for me to be here representing NOAA.

To my right is another familiar NASA fellow who is the new Assistant Administrator for the National Earth Satellite Service, Dr. John McElroy. As you know, John previously served as the Deputy Director for the Goddard Space Flight Center for the National Aeronautics and Space Administration.

Mr. Chairman and members of the subcommittee, I am pleased to report on NOAA's fiscal year 1983 budget request for its satellite services, to discuss the Cabinet Council on Commerce and Trade policy review of LANDSAT commercialization, review the status of NOAA's operational takeover of LANDSAT, and to briefly describe our proposed plans for the reorganization of NOAA as it will affect satellite services.

(Slide 1.) As you know, the object of NOAA's meteorological satellite program is to provide continuous observations of environmental conditions of the Earth's surface, oceans, atmosphere and near space. Since 1960, data from the experimental and operational environmental satellites have contributed significantly to the Nation's environmental monitoring, prediction and warning services. Similarly, the objective of the LANDSAT progam is to monitor the Earth's surface through remote sensing in order to obtain data for locating, developing, and managing natural resources, both renewable and nonrenewable. We expect that LANDSAT, which will soon be moving into an operational phase, will prove to be a valuable source of information for both the private sector and governmental communities.

The fiscal year 1983 budget maintains these important programs at levels which will accomplish basic program objectives. The total fiscal year 1983 budget request for the National Earth Satellite Service is $151.498 million. The fiscal year 1983 increases provide for system changes for compatability with the NASA communications network and procurement and launch services for the ongoing satellite program. A request for LANDSAT funding will be offset by user fees.

(Slide 2.) Included in the NESS budget are $62.859 million for the GOES spacecraft, launching and ground systems—no change in the fiscal year 1983 requirement as projected in the fiscal year 1982 budget; $25.641 million for Polar spacecraft, launching and ground systems—a decrease of $24.7 million from the fiscal year 1982 budget; and $14.955 million for the land remote-sensing satellite system—all of which is expected to be recovered through offsetting non-Federal user fees.

Also included in the $151.498 request are $41.521 million to fund meteorological satellite operations and data services and $6.522 million to support research and development—representing no change in the fiscal year 1982 base.

I will only briefly describe the meteorological satellite programs since the focus of my testimony, as you requested, is the LANDSAT program.

(Slide 3.) The fiscal year 1983 budget request for $62.859 million maintains the two-satellite configuration for GOES which is critical to provide repetitive reviewing of the development and movement of destructive weather systems over much of the Western Hemisphere.

(Slide 4.) Although the budget identifies an increase of $35.5 million over the fiscal year 1982 budget, this amount actually represents a continuation of the procurement for GOES satellites already underway, and it is not an enhancement to the budget.

In summary, the GOES budget request entails: no change in the fiscal year 1983 actual budget as projected in the fiscal year 1982

budget since the difference between the fiscal year 1982 and fiscal year 1983 budget is due to the normal expenditure rate for GOES G, H, and I spacecraft to be purchased starting in fiscal year 1982. The planned launch date for GOES G is fiscal year 1985; and a $7 million ground system request for compatibility with changes being implemented by NASA in their communications network.

(Slide 5.) The current GOES satellites, GOES 4 and 5, were launched on September 9, 1980 and May 22, 1981, respectively, and are located at 75 degrees and 135 degrees west longitude. These satellites comprise part of the global network of geostationary meteorological satellites. Other nations and international organizations with existing and planned geostationary satellites are Japan, India, the European Space Agency, and the Soviet Union.

With the fiscal year 1983 budget, sensor procurement and construction of GOES F through I will continue. Launch of GOES F is planned for the early part of 1983 but actual launch will not take place until the failure of GOES E.

The principal sensor on the GOES satellites is the visible infrared spin-scan radiometer atmospheric sounder (VISSR) which we call VAS.

(Slide 6.) The VAS provides the first measurements of atmospheric temperature and moisture from a geostationary satellite and can be commanded to scan parts of the Earth at 3- to 15-minute intervals in order to monitor the development of tornadoes and other severe storms. Sufficient VAS data has been obtained to demonstrate their potential for improving North American weather forecast models over the eastern Pacific; diagnosing moisture patterns and circulations not otherwise evident in other upper air data; enhancing diagnoses of frontal and squall line structure; and improving height assignments to cloud-motion winds.

In addition to VAS, GOES satellites also carry a data collection system for the collection of environmental data from the remote observing platforms, and a space environment monitor which provides solar radiation data to NOAA's Space Environmental Laboratory.

(Slide 7.) NOAA's polar-orbiting satellite system, also called the NOAA or TIROS–N series, collects global observations in support of numerical weather analysis and prediction, flood forecasting, water resource management, fishing, shipping, and ocean monitoring services, crop production forecasting, and solar activity monitoring.

[Slide 8.] The 1983 budget request of $25.641 million for polar spacecraft, launching and ground systems, represents a reduction of $24.665 million from the fiscal year 1982 base. This request reflects the proposal to reduce polar-orbiter coverage from a 2- to 1-spacecraft system with replacement launches planned for 18-month intervals. The request allows for the delay of NOAA H though J spacecraft procurement to fiscal year 1984. We expect to save approximately $271 million in Federal expenditures over the life of the revised polar orbiter spacecraft launch plan by 1992 while still providing coverage of essential weather information needed by the United States.

The requested budget will enable: environmental testing and launch of NOAA E; fabrication, integration, and testing of NOAA

D through G; sensor procurement for NOAA H through J; detail design study to modify NOAA H through J for the Shuttle launch vehicle; continued refurbishment of the Atlas F launch vehicles; and improvements in operational effectiveness of the data processing system.

In addition to the amounts requested for weather spacecraft procurement described above, the budget also contains $41.521 million for weather satellite operations and $6.522 million to support research and development. The operations budget pays for operation and maintenance of the command and control facilities, including contractor personnel at the Wallops Island, Va., station and at Gilmore Creek, Alaska; satellite field service station operations in Washington, D.C.; Miami, Kansas City, San Francisco, Anchorage, Honolulu, and Slidell, La.; and facilities for centralized data processing and analysis. The R. & D. budget, maintained at the same level as fiscal year 1981 and 1982, provides research in the development of new and improved methods of obtaining satellite data and more effective uses of the data in environmental monitoring, prediction and warning.

[Slide 9.] NOAA is requesting an fiscal year 1983 appropriation of $14.955 million to support its operation and management of the U.S. LANDSAT system. However, the total cost of operating LANDSAT operations in fiscal year 1983 is $24.74 million.

NOAA hopes to recover the total cost of LANDSAT operations from the sale of LANDSAT data to Federal and non-Federal users. The revenues from non-Federal users collected will be paid into the U.S. Treasury to offset the NOAA appropriation.

The difference between the amount NOAA is requesting and the total Federal Government request will be reflected in the budgets of Federal-user agencies, including the Department of Agriculture, the Department of Defense, the Department of Interior, and the Central Intelligence Agency. These and other user agencies will reimburse NOAA for their respective shares of LANDSAT operating costs. I urge the support of the members of the subcommittee in obtaining from your colleagues on other committees those necessary Federal-user agencies' budget requests. The funds will be used to contract for the management of the ground system at the Goddard Space Flight Center; to reimburse the Department of Interior's EROS Data Center at Sioux Falls, S.D., for the archiving of LANDSAT data and the provision of retrospective and other data services; and for NESS management of the program.

Let me turn now to the Cabinet Council on Commerce and Trade. The Cabinet Council on Commerce and Trade is examining two issues pertaining to civil operational satellites. One is what is the best mechanism to implement the policy of transfer of civil land remote-sensing systems to the private sector as soon as possible. The other is should we simultaneously transfer to the private sector both civil weather and land remote sensing systems.

The Cabinet Council met on December 16, 1981 to discuss the first issue. Consideration of the second issue was temporarily deferred until LANDSAT policies are resolved. The Cabinet Council requested additional information on benefits and related costs for LANDSAT-type data, that is, what is the long term LANDSAT-type data worth to the Federal Government and the Nation and

how do the benefits compare to the costs. The additional information has been prepared and provided to the Cabinet Council. As soon as the Cabinet Council has reconvened and has decided this important issue, I will be very glad to share the results with the members of this committee and its staff. I am confident that in reaching a decision on how to commercialize land remote sensing systems, the element of competition will be a prime consideration.

NOAA is on schedule to assume responsibility from NASA for the operation of the new LANDSAT D system. The LANDSAT D system is the next generation, dedicated land remote sensing satellite system which is designated to satisfy continuing requirements for timely, accurate, and reliable data on the Earth's resources. We expect the LANDSAT D system, with its new higher resolution thematic mapper, will improve the ability to locate minerals, oil and gas, and other nonrenewable resources; to monitor and forecast global crop production; to manage its renewable resources; and to monitor major floods and other natural disasters.

LANDSAT D will carry the thematic mapper sensor, which is an experimental one, in addition to the multispectral scanner, the operational sensor, and it is scheduled for launch in July of this year. LANDSAT D prime will be completed in mid-1983 and launched in 1985, assuming no failure of LANDSAT D. NOAA will assume responsibility for operating the spacecraft and producing LANDSAT multiscanner tapes and images as soon as acceptable performance criteria are met for the LANDSAT D which is expected to be by January 31, 1983. NOAA will assume responsibility for managing the thematic mapper activity in approximately January 1985 after NASA has completed a 2-year R. & D. effort. Incidentally, we expect that the thematic mapper will provide better coverage of the visible reflected light spectrum than the planned foreign competitors' systems

We have taken the following specific steps to assure a smooth transition of operating responsibility from NASA to NOAA. We have created a LANDSAT operations group in NOAA. Staffing of this group is now 60 percent complete, and it will be fully staffed 6 months before takeover.

We have issued a request for proposals for a contractor to manage the spacecraft command and control and data preprocessing functions at the Goddard Space Flight Center.

We have reached an agreement in principle with the EROS Data Center on NOAA's management of the data processing, delivery, and billing functions at the EROS Data Center.

We have negotiated with NASA the detailed terms for turning over the spacecraft and ground system to NOAA, including the eventual responsibility for TM data and for continued NASA assistance after the transition.

With NOAA's takeover of LANDSAT operations, the United States will have for the first time a single manager of the LANDSAT program from spacecraft command and control to data production and dissemination. NOAA will have onsite managers at the EROS Data Center. This system will allow customers with specific requirements, that is, field tests, to obtain from the satellite coverage over their particular areas of interest to gain access to that data.

The LANDSAT D system is designed to provide preprocessed data to realtime users such as the Department of Agriculture within 48 hours. We anticipate that products from the EROS Data Center will be delivered to buyers on a more routine basis than for current experimental systems. To match these new and improved services, NOAA has announced a new pricelist for LANDSAT products effective October 1, 1982, a copy of which is attached to my statement which I will provide for the record.

NOAA has also advised the 11 foreign ground stations now receiving LANDSAT data directly that the annual fixed access fees will be increased and that they will have to pay distribution fees based on the type and the number of products distributed by station operators. Recovery of the LANDSAT operating costs will relieve the U.S. taxpayers of the burden of subsidizing specific program beneficiaries. We are in the process of drafting new agreements for these stations to replace existing agreements signed by NASA. These agreements will incorporate the new prices.

To advise NOAA in planning for the operational takeover and commercialization of LANDSAT, we are creating a 15-member non-Federal Land Remote-Sensing Satellite Advisory Committee. The Secretary of Commerce is in the process of making final selections for the committee from more than 160 nominations received to date. The advisory committee is expected to meet in April 1982. The meetings will be open to the public. This subcommittee then, of course, will be notified of all meeting dates and the minutes of each meeting will be made available.

On May 5, 1981, Secretary Baldrige sent the Congress an administration-proposed bill to authorize the Department of Commerce to plan and provide for the management and operation of a civil land remote-sensing system and to charge user fees. This bill would authorize $2.1 million for fiscal year 1982 and such sums as may be necessary in fiscal year 1983. Now the administration's fiscal year 1983 budget has been transmitted to the Congress, I request that you amend the authorization bill previously submitted to incorporate the fiscal year 1983 budget request for LANDSAT of $14.955 million and pass the amended bill. The Secretary of Commerce has sent the letter to Congress confirming the administration's support of this legislation and requesting the necessary technical amendment.

When this legislation is enacted, NOAA will have clear authority to operate the LANDSAT satellites and to charge fees for LANDSAT products that recover our operational costs.

After the Cabinet council concludes its policy review of civil remote-sensing satellite commercialization, we anticipate forwarding for your consideration amendments to this legislation. The amendments would establish a process for commercialization of those satellite services which can best be commercialized and likely will include a request for authority to transfer some or all of the Government's assets if to do so would be in the best interest of the United States.

Recently, the NOAA Administrator announced that he will soon send to the Secretary of Commerce a formal proposal to restructure certain parts of the NOAA organization. This restructuring is necessary to: (1) organize NOAA's varying functions more logically; (2)

to enhance communications and coordination throughout the agency; (3) to reflect more accurately budget priorities; and, finally, reduce administrative overhead. We expect to send our proposal to the Secretary later this month.

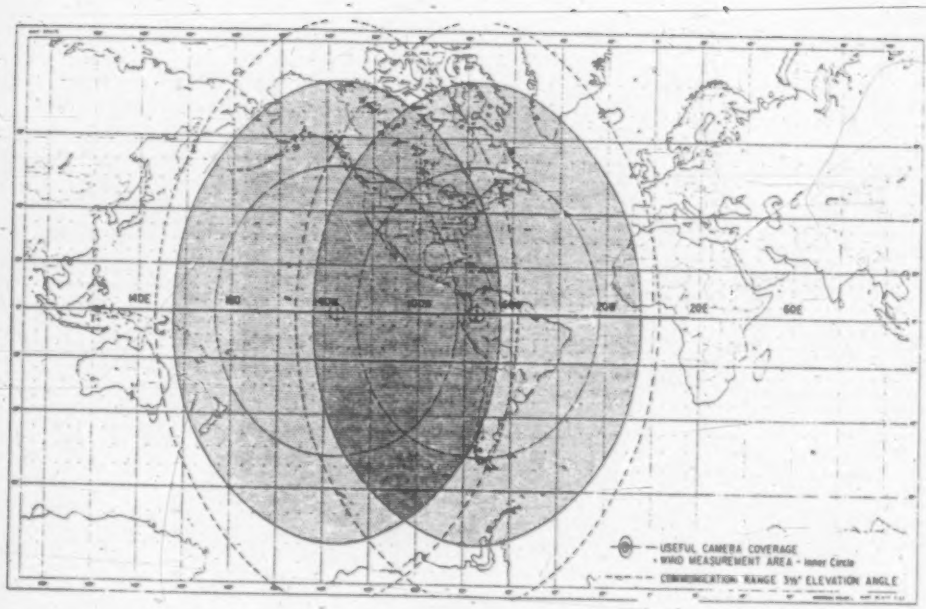
In recognition of the close relationship between the satellite data gathering capabilities of the agency and our data information processing and dissemination functions, these two activities may be brought together under a single Assistant Administrator. This new component will provide data and information services to users both inside and outside the agency.

We do not believe that the proposed reorganization will have any significant impact on our operational satellite remote sensing activities.

Mr. Chairman, this concludes my prepared remarks. Thank you for the opportunity to appear before you. I believe that the fiscal year 1983 budget for NOAA's operational satellite services represents a program balanced between the Nation's needs for environmental and land remote sensing satellite data and services and the need to impose fiscal restraint on the Federal budget. We are moving to transfer to the private sector those activities which can best be carried out there while at the same time maintaining responsibility in the Government for activities vital to overall U.S. interests.

I will be happy to answer any questions you and the committee members may have.

[Slides 1–9 of Dr. Calio's oral presentation follow:]


180
20W
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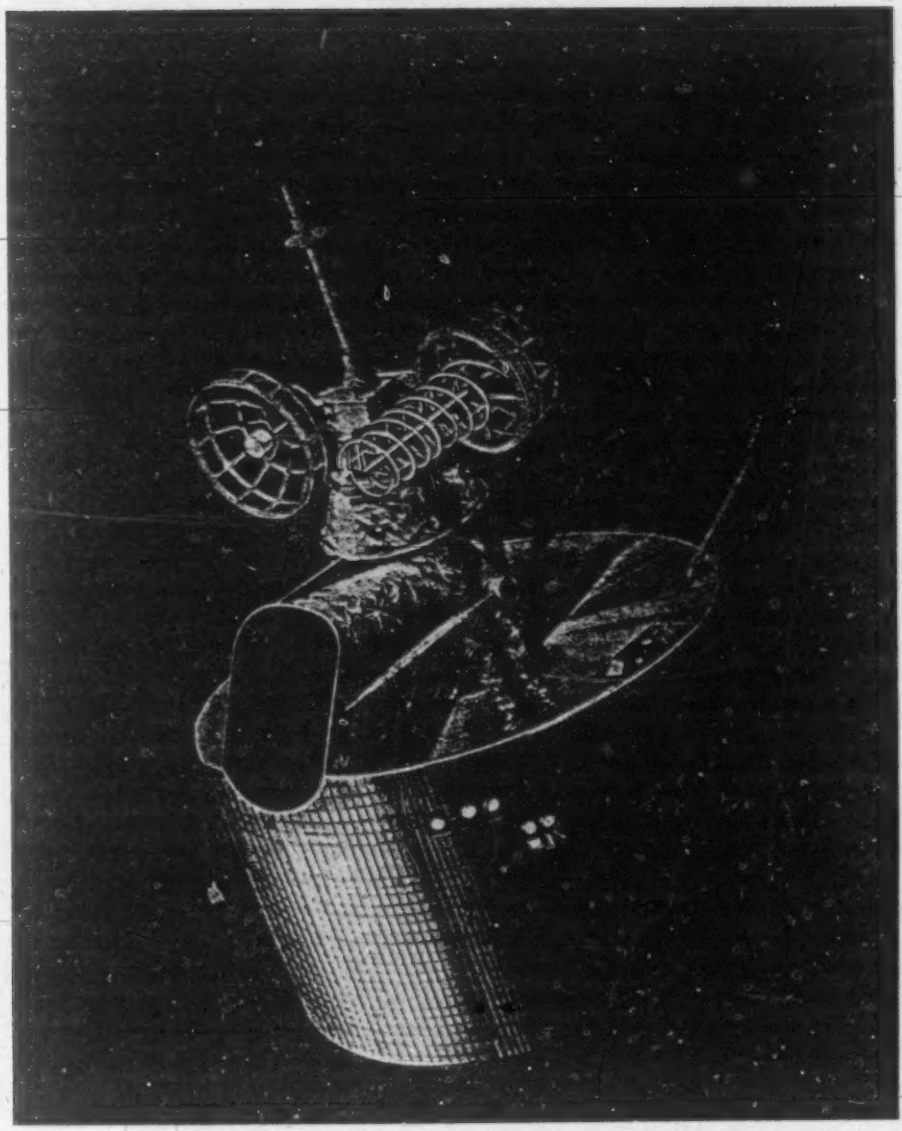
USEFUL CAMERA COVERAGE
WIND MEASUREMENT AREA - Inner Circle
COMMUNICATION RANGE 5½° ELEVATION ANGLE



NOAA
• FORECASTING
• SEA SURFACE TEMPERATURES
LANDSAT
• RENEWABLE RESOURCES
• MINERAL EXPLORATION
GOES
• WEATHER WARNINGS
• DATA COLLECTION SYS.
GOES
• WEFAX
• SOLAR MONITORING

93-418 O—82—70

NATIONAL EARTH SATELLITE SERVICES (NESS) FY 1983 CONGRESSIONAL SUBMISSION $K

	1982 Currently Available	1983 Base	1983 Estimate	Inc. (+) or Dec. (-)
I. WEATHER SATELLITE SERVICES				
• GEOSTATIONARY SPACECRAFT, LAUNCHING AND GROUND SYSTEMS	$27,395	$27,395	$62,859	$35,464
• POLAR SPACECRAFT, LAUNCHING, AND GROUND SYSTEMS	50,306	50,306	25,641	- 24,665
• OPERATIONS (WEATHER)	39,780	41,521	41,521	— — —
• SUPPORTING RESEARCH AND DEVELOPMENT (WEATHER)	6,218	6,522	6,522	— — —
TOTAL WEATHER SATELLITE SERVICES	$123,699	$125,744	$136,543	+$10,799
II. LAND SATELLITE SERVICES				
• OPERATIONS (LAND)	1,100	1,400	14,955	+ 13,555
III. TOTAL NESS	$124,799	$127,144	$151,498	+$24,354

1099

Mr. FLIPPO. Thank you, Dr. Calio, for your testimony. This is a very interesting area for the committee to consider, and an important area for the Nation to be considering.

I notice that you feel that some of the $14.9 million cost of the land remote sensing system would be recovered through offsetting non-Federal user fees. Have you conducted any market surveys? What leads you to expect that those fees will be recovered?

Dr. CALIO. The formula used to establish this particular number was based primarily on historical records. We went back to the EROS Data Center, looked at sales activity over the past few years, and the indication was that approximately 50 percent of the sales was purchased by non-Federal consumers and 50 percent by Federal agencies. That is how we obtained the approximate 50/50 split.

Looking at the volume of the sales at current prices and taking into consideration the increase in price, which is approximately a factor of 2½, we then arrived at the number of approximately $15 million in non-Federal consumption.

Mr. FLIPPO. Do those user fees that you are considering charging stay with NOAA or do they go directly to the Treasury?

Dr. CALIO. They will go back to the Treasury.

Mr. FLIPPO. Is that true in the new legislation that you are requesting?

Dr. CALIO. Yes, Mr. Chairman, currently we have no authorization legislation. The May 5, 1981 bill provides NOAA with necessary authority to collect user fees. Now we are proposing a simple budgetary update to that bill changing the fiscal year 1983 authorization request to correspond to the fiscal year 1983 budget submission.

Mr. FLIPPO. You indicated launch every 18 months for the NOAA-series satellites. What is the lifetime for those satellites historically?

Dr. CALIO. Do you mean for the polar-orbiting satellites?

Mr. FLIPPO. Yes.

Dr. CALIO. The design life for the polar-orbiting satellite is 2 years. To date, that is what we have obtained with the TIROS-N series. The first TIROS-N, I believe, lasted 27 months, slightly over the 2-year period. NOAA 6 is still working and it is now 33 months old.

Mr. FLIPPO. What I am trying to get at is, you are going to a one-satellite system.

Dr. CALIO. Yes, sir.

Mr. FLIPPO. What risks are you running where you have the situation where you will not have the service available, for instance, if you have a bad launch. Do you always keep a satellite on the shelf? What is your risk of loosing coverage?

Dr. CALIO. I don't have the probability calculations but I can probably estimate that risk for you. I can try to discuss that narratively, if I may.

I am going to ask Dr. McElroy to correct me if I make an error here but in connection with spacecraft in production to date NOAA D and E are both available at the current time for launch. Should we experience a launch failure of NOAA E—we have already experienced one with NOAA B—we will have NOAA D readily availa-

ble to be launched. NOAA E is going to be launched first because it will be the first to carry the search and rescue experiment.

The time delay occurs in rescheduling a new launch vehicle capability. According to our agreements with NASA, we have a 150-day callup capability. Therefore, that says, assuming we don't have double-failure, that there could be as much as a 150-day gap between the launch failure of one spacecraft and the attempt to launch a second spacecraft.

That gets us back into why we have moved the launch frequency to 18 months. In anticipating a 2-year lifetime for the existing spacecraft, we are proposing to launch the replacement spacecraft 6 months prior to its anticipated failure, thus giving us a hot spare in orbit at the time that the demise of the spacecraft would occur.

As you well know on this committee, it is very difficult to predict how long those spacecraft will last. However, that is the theory underlying the 18-month launch. We would like replacement launches to precede failure by about 6 months.

Mr. FLIPPO. Dr. Calio, as you know, NASA is phasing out their support of NOAA satellite improvement R. & D. Is NOAA picking up this work? Who will pick it up?

Dr. CALIO. We do not have a provision to pick up that activity in our current fiscal year 1983 budget. I believe that funds are still available, even though they are phasing down that activity, in the NASA budget for fiscal year 1983, phasing out of the activities they currently have underway.

We anticipate that such an item would have to be considered in budgets for fiscal year 1984 and beyond.

Mr. FLIPPO. The difference between the amount that NOAA is requesting and the total Federal Government request, you indicated would be reflected in the budgets of the Federal-user agencies such as the Department of Agriculture, DOD, Interior, and so forth. Have you determined whether or not those agencies have those moneys included in their budgets at the present time?

Dr. CALIO. In the final decision process with the Office of Management and Budget, allowances were made for those dollars in their budgets, and those requests should be coming forward. I have not examined in detail the requests of those departments' budgets to see whether, indeed, those requests are there. However, the allowance should have been made.

Mr. FLIPPO. Dr. Calio, you talk about the Cabinet Council on Commerce and Trade policy review, and you make the statement that the Cabinet Council is examining the best mechanism to implement the policy of transfer of civil land remote-sensing systems to the private sector "as soon as possible".

The question that comes to my mind about that statement is when was this policy adopted? When was it concluded or when did we have a policy? Is there one written out about the transfer of this remote-sensing system to the private sector, and when is "as soon as possible"? Is there a deadline?

Dr. CALIO. Let me see if I can handle that in two pieces. First, when was that determined? The determination came through the budgetary process and the submission of the revised fiscal year 1982 budget. In that revision, the Reagan administration proposed that the Federal commitment for LANDSAT observing systems

would end with LANDSAT D prime. Assuming a 3-year lifetime for each of those satellites—D and D prime—and assuming that LANDSAT D would be launched in the middle of 1982, it would provide a capability through 1988 for the collection of remotely acquired data over land surfaces. That would provide adequate time for the Government—now I am getting into the second part—to see if and how and by what mechanism it would transfer those responsibilities to the private sector.

On the second part, there is no date established by which time this transfer has to take place, other than that specified in the budgetary process. If we were looking for continuity of service, it would have to be before fiscal year 1988. I guess you would have to back up in time a little further than that if you were to have a replacement spacecraft to be provided by the private sector since it takes about 4 years—3 to 4 years—to develop and manufacture spacecraft. The decision would have to be in place around 1984 or 1985. That is assuming the successful operation for both of those satellites for a 3-year period each.

Mr. FLIPPO. Do you believe that a public debate or hearings or a series of hearings to determine what is in the best interest of the United States would be helpful in the consideration of this matter?

Dr. CALIO. I hesitate in answering that, Mr. Chairman. I was reflecting back on history, and it was my impression that such hearings and debate took place last year. Is that correct, sir?

Mr. FLIPPO. We did have some debates. I think they raised probably a great deal of questions. I was just wondering if those hearings were being considered by the Cabinet Council committee—the hearings that we held in the past.

Dr. CALIO. Are we looking at the results?

Mr. FLIPPO. Yes.

Dr. CALIO. Yes, we are, sir.

Mr. FLIPPO. I would like to ask you if you can tell us whether or not the committee that is considering this has given any thought to the issue of recoupment that was raised in the previous hearings. The American people have paid for this system. They have taken the risk because the risks were too great for others to take. I just wondered if that whole issue of recoupment was even being considered by the Cabinet Council committee, to your knowledge.

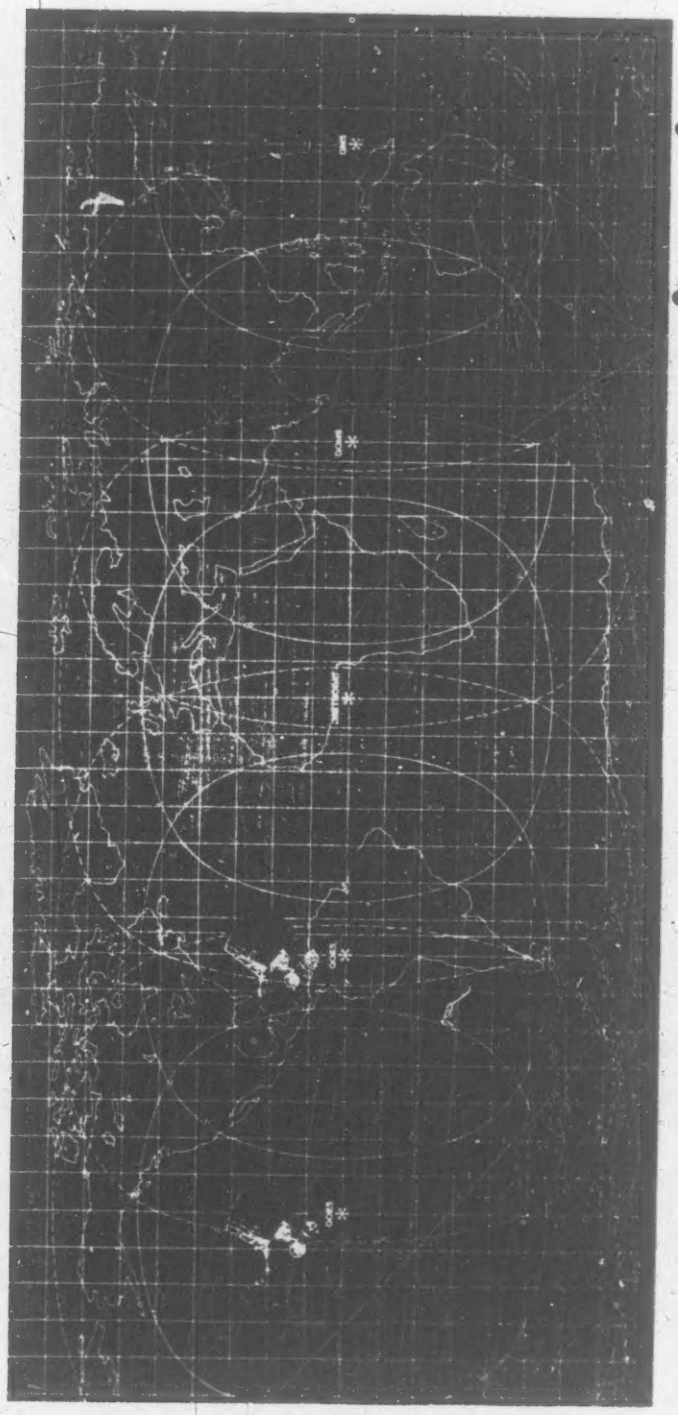
Dr. CALIO. Those thoughts are being presented to the Cabinet Council.

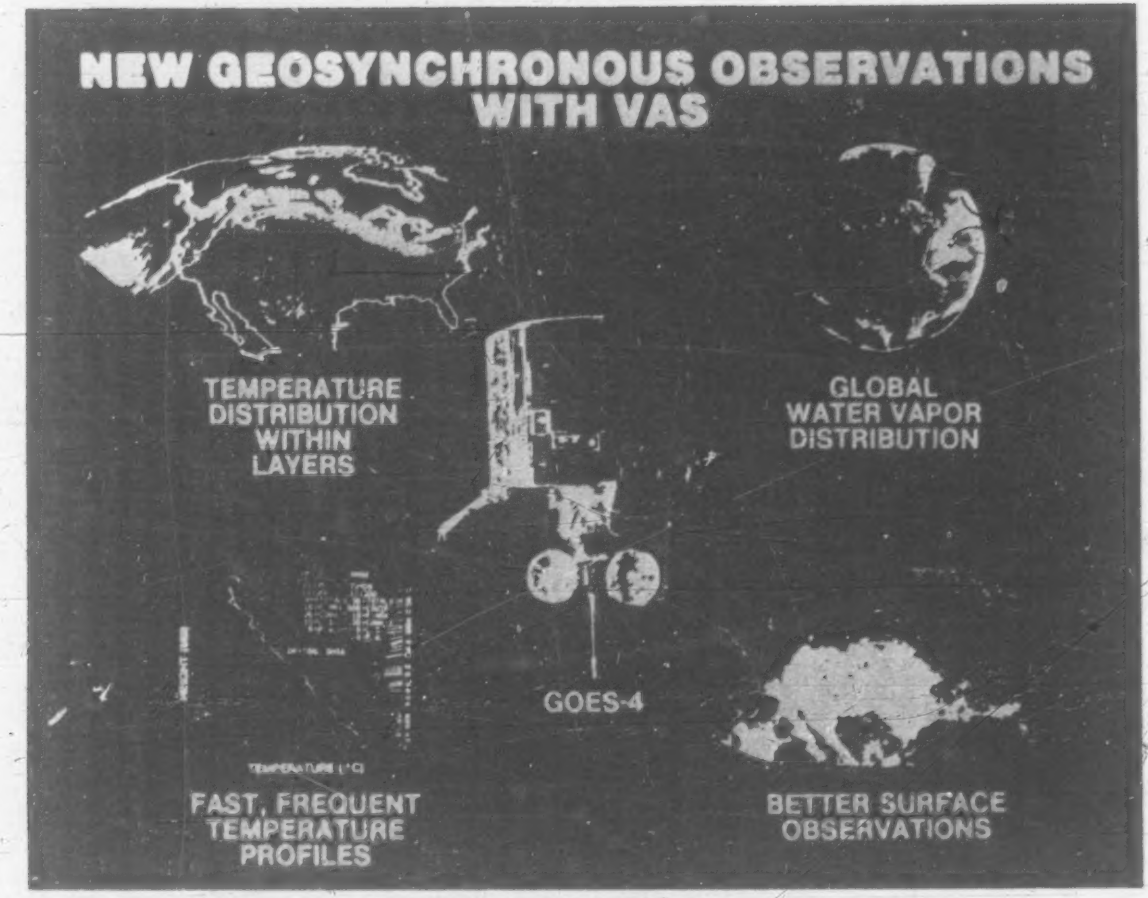
Mr. FLIPPO. Mr. McGrath?

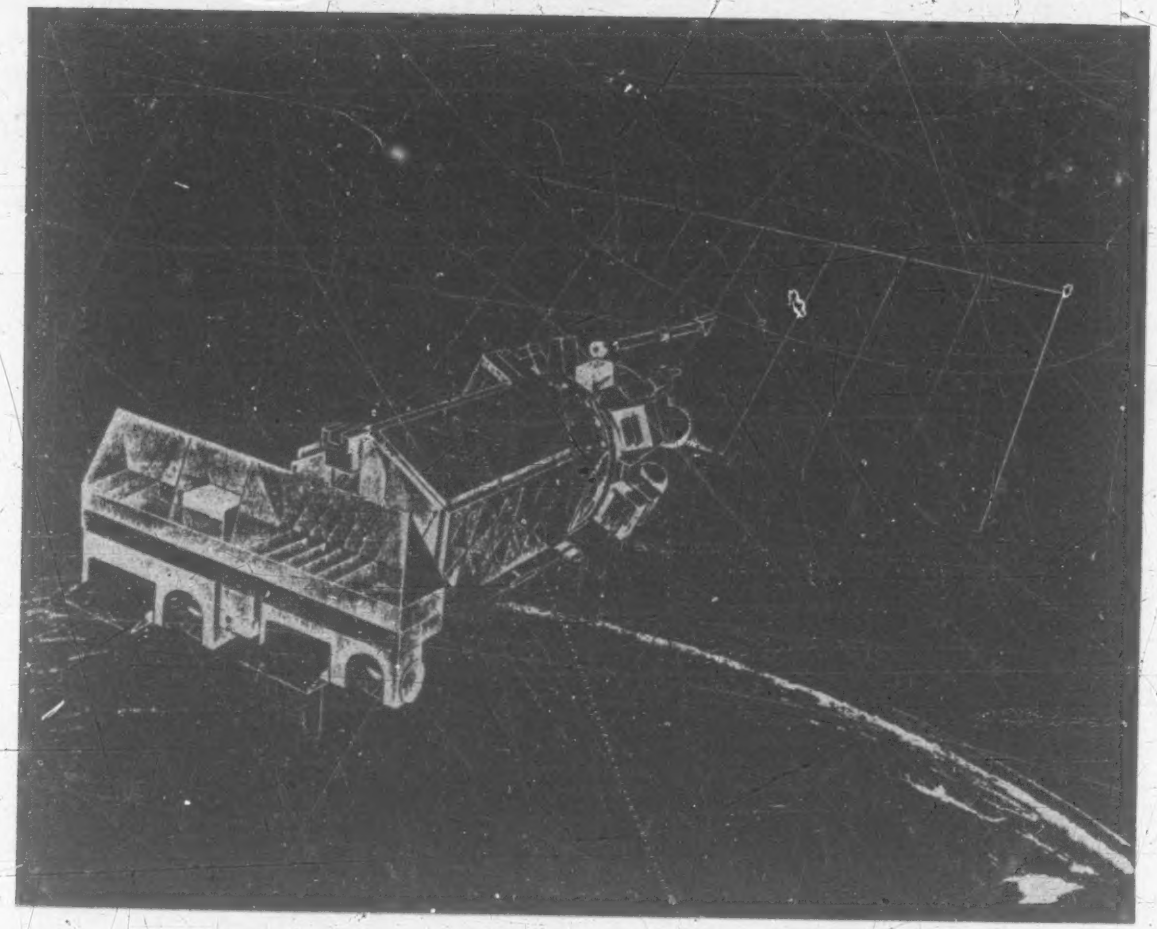
Mr. MCGRATH. Thank you, Mr. Chairman. I would just like to follow up on some of that discussion. We had a lengthy set of hearings—joint hearings with Jack Schmitt's committee last year on this particular subject. The more we got into it, the more problems came to light. Recoupment was one of them.

Under what kind of circumstances do you envision a transfer of NOAA responsibilities to the private sector, or in the case that we were looking at last year, it wasn't so much private sector as a semiprivate sector—COMSAT.

They came in with a proposal which described the sale of existing facilities from the Government to COMSAT, over a period of time for a certain amount of money which was not determined, at least, not publicly determined, for information which at that time




NEW GEOSYNCHRONOUS OBSERVATIONS WITH VAS
TEMPERATURE DISTRIBUTION WITHIN LAYERS
GLOBAL WATER VAPOR DISTRIBUTION
GOES-4
FAST, FREQUENT TEMPERATURE PROFILES
BETTER SURFACE OBSERVATIONS

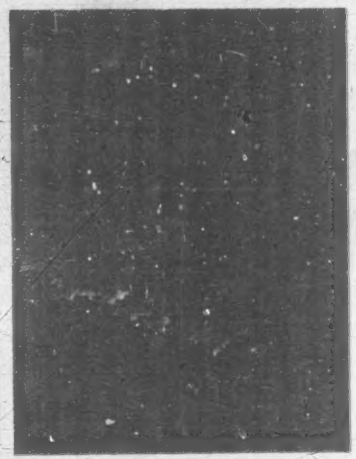


POLAR PRODUCTS

SEA SURFACE TEMPERATURE

SEA ICE

CROP ASSESSMENT



#9

LAND SATELLITE SERVICES
FY 1983 CONGRESSIONAL SUBMISSION — $K

	1982 Currently Available	1983 Base	1983 Estimate	Inc. (+) or Dec. (-)
TOTAL REQUIREMENT	$1,100	$1,400	$14,955	+$13,555
PERMANENT POSITIONS	25	25	25	———

LANDSAT REVENUES (PROJECTED $K)

- LEGISLATION REQUIRED TO PERMIT COLLECTION OF USER FEES FROM NONFEDERAL USERS

RECOVERY OF COST:

FROM OTHER FEDERAL AGENCIES	9,785
FROM NONFEDERAL AND FOREIGN	14,955
TOTAL	24,740

1106

was to be provided to the Government and all other users at a certain percentage above the cost in order to make it work.

How do you envision this particular takeover?

Dr. CALIO. One possibility at one end of the spectrum is what you have described. We have no definitive technique or mechanism established yet. That is one of the issues which is going before the council at the present time.

Mr. MCGRATH. In other words, there has been no decision by the council to sell Government satellite launch facilities—ground tracking stations and whatever—to private enterprise or semi-public enterprise.

Dr. CALIO. There has been no decision to date. It has been presented to them, but that is one option. The Government could, indeed, sell off its assets or part of those assets to the selected contractor for the provision of certain data that the Government would guarantee to procure. That is one end of the spectrum.

The other end of the spectrum that one might consider—and there are all sorts of variations in between—is that since the assets represent sunk costs, it is possible that the Government could, indeed, give away its assets, but not commit to buy any specified quantity of data in the future, thus, not providing a subsidy. The Governmen could allow the new entity to work in the free enterprise system and the U.S. Government would buy whatever data it needed. Therefore, you can see the full range of possibilities that can be developed in between these two concepts.

Mr. MCGRATH. Now, let's talk about that market for that information which comes out of remote sensing satellites. You said in your statement—or maybe in answer to the chairman's question—that 50 percent would be able to be recouped from non-Federal moneys. What is included in non-Federal moneys? Would that be State use of LANDSAT information?

It seemed to me during the hearings last year—this is what I am trying to get at—other than for oil companies and some other particular private enterprises, everybody else who used Landsat equipment information was either a government, a college, other governments—foreign governments to which we provided at either low cost or no cost. I am trying to figure out what is non-Federal and whether or not that non-Federal private sector can really make up for the cost of the money you are asking for.

Dr. CALIO. You asked a particular question about the States. Let me check with a colleague. The States are included in the non-Federal.

Mr. MCGRATH. States presently do not pay anything for that information, am I correct?

Dr. CALIO. No. That is not correct. They do pay. When they request——

Mr. MCGRATH. What information?

Dr. CALIO. Oh, excuse me. Are you talking about land or weather?

Mr. MCGRATH. A little of each because I think the package is going to be both.

Dr. CALIO. Well, excuse me. The answer to the chairman's question had to do specifically with how we established the pricing formula for the LANDSAT data.

Mr. McGRATH. Right.

Dr. CALIO. My answer to your question that the States are included in the non-Federal part has to do with LANDSAT data. It has nothing to do with weather——

Mr. McGRATH. Meteorological data.

Dr. CALIO. No, it is only LANDSAT data, Mr. McGrath, and that is very specific. The other non-Federal users are private industry and foreign purchasers.

Mr. McGRATH. What about the colleges?

Dr. CALIO. The colleges buy their data through the EROS Data Center for LANDSAT data today.

Mr. McGRATH. All right. Now, under the proposed transfer, what price would they be paying as opposed to what they pay today?

Dr. CALIO. A factor of 2½ times more, which starts at the beginning of October 1982.

Mr. McGRATH. With the one polar-orbiter system—this is just to back up the chairman's question—how would we be able to predict whether the one polar orbiting satellite was not functioning?

Dr. CALIO. That has two parts. Let me answer the data gap in two ways. If we have only one spacecraft, we would not be collecting four times—we collect global coverage four times a day with the two satellites—it would be down to two. The impact in the data gap is that it would affect our research activities—to better understand climate, in that we are looking at diurnal variations globally of atmospheric conditions. It is important to global data sets for us to be better able to understand the climatology of the atmosphere for the future is.

We do physically miss, with the lack of one satellite, certain areas at the Equator. That is one part of the gap as far as data coverage goes. The other gap is a very difficult one to predict. That is if the event the chairman suggested does occur. In the event of a failure, would we have a hot spare? If that were not the case, if we did not have a hot spare in place, and we had to wait 150 days to replace that polar-orbiting satellite, there would be severe impact in initializing the production of the models—the prediction models—that we use in our daily global weather forecast, and in the guidance that the National Meteorological Center provides to the U.S. weather forecasters in initializing their assessments for regional and local forecasts.

Mr. McGRATH. Isn't it true then that in the case of a one-satellite failure, that we don't have the sensing mechanism here any longer? We would be going back to pre-1940 methods to determine the weather?

Dr. CALIO. Not quite. We would lose a very important element with the loss of satellite data in that it provides global coverage. However, several things have happened over those intervening 40 years. We have had a tremendous improvement in high-speed computation around the world. We have had tremendous improvement in our communications capability, both terrestrial and via space. We have had tremendous improvement and technological advances in ground observations like radar systems.

The data collected from other places in the world could be communicated back to the National Meteorological Center. The data quality would not be as good because of fewer data sets, but it

would not degrade all the way back to the 1940 timeframe because these other added capabilities have progressed over the years. However, there would be a degradation.

Mr. MCGRATH. I would like to get back to those hearings that we had on the transfer of LANDSAT to the private sector. It seemed to me at the time—and maybe others could answer this question—among those who were opposed to the transfer were the oil companies. Some of the bigger companies were also opposed to it.

Philosophically, do you believe that the policy of transferring our remote-sensing responsibilities to the private sector is in the best interest of the Nation?

Dr. CALIO. My answer to that has to be yes. The question that remains in my mind is how and when.

Mr. MCGRATH. Then the question which would remain in my mind is how much and at what cost.

Dr. CALIO. Precisely.

Mr. MCGRATH. Thank you.

Mr. FLIPPO. Mr. Brown?

Mr. BROWN. I don't have a large number of questions, Dr. Calio, but I am interested in this process with regard to the transfer of LANDSAT.

I think the committee at some point is probably going to have to make recommendations with regard to any legislative requirements that may be involved in the transfer of this system. For that purpose, we are going to have to have at least some part of the basic data which is being provided to the Cabinet Committee for purposes of their making their decision. You have agreed to provide that?

Dr. CALIO. Yes, sir. As soon as the council makes their determination, we will make that data available to you, sir.

Mr. BROWN. Just as a matter of general interest, I presume that a number of alternatives are being considered, possibly something similar to the COMSAT operation or other models that have been developed, for the transfer?

Dr. CALIO. Specific models for the transfer are not being looked at by the Council. The Council is trying to resolve major policy issues as to scoping the total assets associated with Government activity and what they should be. It is trying to determine how one provides continuity of data if that is, indeed, an issue. First of all, is it an issue, and, if so, how is that reflected in total national assets?

Those are the kinds of issues they are looking at, rather than looking at specific mechanisms or models.

Mr. BROWN. Would it be the intention of the Cabinet Council, having looked at the problem from that standpoint as you have described it, then to ignore the question of specific mechanisms or models that would be used for the transfer?

Dr. CALIO. That is the concept, more specifically, with Secretary of Commerce Baldrige. Of course, NOAA would be the agent in that regard. Yes.

Mr. BROWN. Well, there are extremely significant policy issues involved in the question of what kind of a model is used for transferring this to the private enterprise sector. This committee has given a considerable amount of thought to this if I interpret the

questions of the members correctly. It is a matter that has relevance to a broader range of issues than merely the transfer of LANDSAT. There are a number of activities, particularly in the development of high technology areas which conceivably can be spun off to private enterprise at some point under certain conditions.

The question I have basically is what factors are entering into this discussion? What kinds of market analyses are being made? This is fundamental to the whole question of how you transfer something that might have profitmaking potential. If you make one estimate of the market, you come to one kind of a conclusion. If you make another estimate of the market, you come to another kind of conclusion.

I am interested in having access to whatever data is being considered bearing on these issues at the appropriate time. The question is, will we be able to get it?

Dr. CALIO. Yes, Mr. Brown. I think that can be provided to the members of the committee and to the staff.

Mr. BROWN. I think that probably we will have to be satisfied with that. You don't have any indications of how quickly this is moving and how soon we might be able to get some data, do you?

Dr. CALIO. I am anticipating the council reconvening in a week or two. Once the council has made its determination, that will put in motion other activities of the Department of Commerce. That data will be generated, and the gameplan will be put together.

Mr. BROWN. With specific regard to the LANDSAT type of operations, how are the Japanese and French operating their systems? Are those continuing to be government operated?

Dr. CALIO. I think the Japanese system is purely government operated. The French case is quite different. I have to make a distinction here because it is a popular conception that COMSAT is a quasi-government organization. It is a profitmaking organization. There are only two or three peculiarities—the reason I want to say that is that I want to define how SPOT operates in a moment—about the COMSAT operation in which it varies from other companies. One is the way in which it was established. Two, the President selects, I think, three members of the board of directors. Three, its regulations are controlled by international agreements and by the Federal Communications Commission. Other than that, there are no Government ties with COMSAT.

Mr. BROWN. You don't consider it a governmental tie that they have an monopoly on international——

Dr. CALIO. By international agreement, that is the part I bring up there. That is the peculiarity in that it has that unique monopoly as being the representative for the United States in INTELSAT.

Mr. BROWN. In the congressional charter.

Dr. CALIO. Yes. That is the unique part about it. The SPOT operation, as best I understand it, is a combination of Government and industry involvement. The Government is a partner. It is a part owner of the system, and the industry is another part owner. The Government owns part of the ground segment and the entire space segment. In the communications field, we don't have that relation with COMSAT today.

Mr. BROWN. No, but with regard to LANDSAT, something very similar has been proposed, that the Government continues to hold on to the space segment and spin off the ground based segment.

Dr. CALIO. That is another option in between what I described with Mr. McGrath. Yes.

Mr. BROWN. Basically, I am just trying to see how much of this information and these alternatives are being considered by the Cabinet Council committee. That is why I am asking you how easy it will be for this committee to get that information. It will have an important bearing, I think, on our own policy reactions.

Dr. CALIO. OK. I have to say again that the council is not considering mechanisms. The council is considering the basic policy issue of what to do and how.

Mr. BROWN. Then when they finish, they will be completely sensitive to the desires of this committee?

Dr. CALIO. I am sure we will, Mr. Brown.

Mr. FLIPPO. Mr. Brown, I think, as you know from the hearings that we had before, many people felt that this was not so much an issue of transferring technology as it is of transferring financial responsibility.

Mr. BROWN. I understand that. That is why I stressed the marketing aspect.

Dr. CALIO. May I hasten to add, Mr. Chairman?

Mr. FLIPPO. Yes.

Dr. CALIO. I made a comment on the LANDSAT Advisory Committee. That is a non-Federal advisory committee made up of representatives from the private sector and from the academic community to advise us on just this very thing, to get their views fed into the whole process.

Mr. BROWN. Well—if I may just seek clarification—we come into this problem at occasional intervals on a not very continual basis without a very good data background so we sometimes do screwy things or ask screwy questions.

Basically, it seems to me if we have a system, which as I understand it, produces x dollars of revenue and the capital investment is 100 x, we have a situation where no private industry is—well, that might depend on what x is. Let's assume we have a situation where the revenues don't come anywhere near to servicing the capital investment. Under those circumstances and with that projection of the market, you come to one conclusion, which is that the Federal Government has to provide a subsidy if it wants some private enterprise to operate it.

If private industry comes in and has done a marketing survey which shows that they can multiply by 100 times over the revenues, but they keep it secret as to how they are going to do that, then we have no idea. On that case we could make some poor policy decisions.

NOAA wouldn't let that happen, would they?

Dr. CALIO. Well, you bring up an interesting point on legislation. That is why it is important for this council to make its decisions because we would then have to come forward to you with amendments if authorization legislation is enacted into law which would allow us to enter into the marketplace and interact with industry in a very positive way, and so that we could dispose of those assets.

The only way that I can see now that we could ever get this kind of data on a truly business negotiation is if we have the wherewithal—we, the agent, and that could be anybody else who is the agent—to deal with the disposal of the assets they currently have.

Right now, it is sort of academic, and that would be one of the things we would be coming forward with in asking you to give us that capability. We are asking the council to allow us to draft that legislation.

Mr. BROWN. I wouldn't expect us to be as imaginative as private industry in projecting private industry needs or markets for LANDSAT data. I would expect us to at least be able to comprehend the Federal Government uses. I am not sure how well we are doing that. I am not saying that we are not doing it. I am just saying that I don't know. I am looking at the Agriculture budget that was just approved this morning. In that budget there are four different bureaus using LANDSAT data and now costing it up in accordance with the recommendations in your statement.

I wasn't completely aware of how extensive the use of that LANDSAT data was, and I am not sure that those four line-item budgets in Agriculture represent all of the uses. My query is aimed at knowing how extensively we have analyzed even the Federal Government market, to say nothing of the State and local government market, for LANDSAT data in making policy decisions.

Dr. CALIO. May I add something there? What you have hit on is the OMB principle exactly. They did not know where the use of LANDSAT data was in the Federal Government. The way to drive that out, to find out, was to make them pay for that capability and have them trade those dollars off against other activities within that particular agency or department. That illustrates where the need is. That is precisely why OMB took the tack that they did.

Mr. BROWN. Yes. I would be interested in seeing the full picture. I think I see it in the agricultural part, but I don't see it yet elsewhere.

Dr. CALIO. We have those other data to the extent of what is being requested in the fiscal year 1983 budget by the other agencies.

Mr. FLIPPO. Mr. McGrath, did you have a followup question?

Mr. MCGRATH. Yes. I have become extremely intrigued with this particular subject. The hearings that we had last year were among the more interesting that we have ever had on the subject. Frankly, I need to be more convinced of the advisability of this particular transfer than what I have heard so far, particularly from this hearing.

Perhaps some of those who are going to be making policy decisions ought to have heard—or maybe you should talk to some of us—about some of our concerns so those concerns can be mollified before they make a decision which would have to come back here legislatively.

Dr. CALIO. I add that it will have to come back here.

Mr. MCGRATH. I am sure that it will. However, right now, it seems to be a bad deal to sell off technology that we have developed, infrastructures that we have developed, satellites that we have developed to an outside agency that is going to charge us back for information that we presently get for our own use for nothing,

and in doing so, also increase the rate for institutions and other levels of Government that are getting data at lower than the projected price is going to be.

I am not convinced, based on the hearing and other information that I have been able find, that there is a private market for this. I want to see some data which shows that the 50-percent non-Federal is going to satisfy the need of a private enterprise. If not, we are going to be back in the business of subsidizing that private enterprise in order for them to make up the necessary money. If the whole thing collapses, we are going to have to take it back. What is the cost of taking it back?

I want to be sure before we go ahead with this thing that all of those questions are answered. Right now, if we had to vote tomorrow, it would not be for this particular policy.

Mr. FLIPPO. Dr. Calio, I think Mr. Brown mentioned his interest in data from other agencies, not just Ag, but other agencies as well. I wonder if you might supply that information to the committee for the record.

Dr. CALIO. I certainly will, Mr. Chairman.

[The information follows:]

LANDSAT funding fiscal year 1982

	Millions
Total	$24.740
NOAA amount	−14.955
Total	9.785
Other Federal agencies:	
Agriculture	7.414
Interior	.200
NASA and national security agencies	2.171
Total	9.785

Mr. FLIPPO. It would be helpful. The other comment—and we will conclude this because we have a very hard-hitting statement from Mr. Cormick that we want to hear, too—I think that from our committee's point of view, the policy decisions, where we are asked to grant authority to NOAA to transfer Federal assets of one sort or another, that are primarily transferring financial responsibilities, financial questions, on our part will be easier to make if we are assured that your agency has examined the financial market. If you are talking about a financial decision, perhaps you have secured adequate financial data on which we are assured that the people's interest is protected in the transferring of those assets.

It will make it much easier for us if your agency has secured expert information on the market surveys and matters of that sort.

Dr. CALIO. I understand, Mr. Chairman. That is why we separated it into two parts. We are asking for the legislation now to allow us to operate the system and collect user fees. We will be back again after the council has met with amendments to the proposed legislation on that particular subject. [As April 12, 1982, the council has not met but is expected to meet on April 20.]

Mr. FLIPPO. We are certain that you acted with great competence in the NASA area, and we expect the same in NOAA and I am sure that expectation will be fulfilled. Thank you very much.

Dr. CALIO. Thank you, Mr. Chairman.

[The prepared statement of Dr. Calio follows:]

TESTIMONY OF
DR. ANTHONY J. CALIO
DEPUTY ADMINISTRATOR
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
BEFORE THE
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

March 3, 1982

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

I am pleased to report on NOAA's FY 1983 budget request for its satellite services, discuss the Cabinet Council on Commerce and Trade policy review of Landsat commercialization, review the status of NOAA's operational takeover of Landsat, and briefly describe our proposed plans for the reorganization of NOAA as it will affect satellite services. (Figure 1.)

The objective of NOAA's meteorological satellite program is to provide continuous observations of environmental conditions of the earth's surface, oceans, atmosphere and near space. Since 1960, data from the experimental and operational environmental satellites have contributed significantly to the nation's environmental monitoring, prediction and warning services. Similarly, the objective of the Landsat program is to monitor the earth's surface through remote sensing in order to obtain data for locating, developing and managing natural resources, both renewable and non-renewable. We expect that Landsat, which will

soon be moving into an operational phase, will prove to be a valuable source of information for both the private sector and governmental communities.

FY 1983 Budget Summary

The budget I am proposing today maintains these important programs at levels which will accomplish basic program objectives. The total FY-83 budget request for the National Earth Satellite Service (NESS) is $151.498 million. The FY 1983 increases provide for system changes for compatability with the NASA communications network and procurement and launch services for the ongoing satellite program. A request for Landsat funding will be offset by user fees. (Figure 2.)

Included in the NESS budget are:

- $62.859 million for GOES spacecraft, launching and ground systems--no change in the FY-83 requirement as projected in the FY-82 budget;
- $25.641 million for Polar spacecraft, launching and ground systems--a decrease of $24.7 million from the FY-82 budget; and
- $14.955 million for the land remote sensing satellite system--all of which is expected to be recovered through offsetting non-Federal user fees.

Also included in the $151.498 million request are:

- $41.521 million to fund meteorological satellite operations and data services and $6.522 million to support research and development--representing no change in the FY-83 base.

I will only briefly describe the meteorological satellite programs, since the focus of my testimony, as you requested, is the Landsat program. (Figure 3.)

Geostationary (GOES) Satellites

The FY 1983 budget request of $62.859 million maintains the two-satellite configuration for GOES which is critical to provide repetitive viewing of the development and movement of destructive weather systems over much of the Western Hemisphere. (Figure 4.) Although the budget identifies an increase of $35.464 million over the FY 1982 budget, this amount actually represents a continuation of the procurement for GOES satellites already underway, and is not an enhancement to the budget. In summary, the GOES budget request entails:

- No change from the FY 1983 requirement as projected in the FY 1982 budget.
- An increase from FY 1982 to FY 1983 due to the normal expenditure rate for GOES G, H and I spacecraft which will be purchased starting in FY 1982. The planned launch date for GOES G is FY 1985.
- A $7 million ground systems request for compatibility with changes being implemented by NASA in their communications network.

The current GOES satellites, GOES 4 and 5, were launched on September 9, 1980 and May 22, 1981, respectively, and are located at 75° and 135° West longitude. These satellites comprise part of a global network of geostationary meteorological satellites. Other nations and international organizations

with existing and planned geostationary satellites are Japan, India, the European Space Agency and the Soviet Union. (Figure 5.) With the FY 1983 budget, sensor procurement and construction of GOES F through I will continue. Launch of GOES-F is planned for the early part of 1983 but actual launch will take place only in the event of a failure of GOES-E.

The principal sensor on the GOES satellites is the Visible Infrared Spin-Scan Radiometer (VISSR) Atmospheric Sounder, called VAS. (Figure 6.) VAS provides the first measurements of atmospheric temperature and moisture from a geostationary satellite and can be commanded to scan parts of the Earth at three to fifteen minute intervals in order to monitor the development of tornadoes or other severe storms. Sufficient VAS data have been obtained to demonstrate their potential for improving the North American weather forefast models over the eastern Pacific; diagnosing moisture patterns and circulations not otherwise evident in other upper air data; enhancing diagnoses of frontal and squall line structure; and improving height assignments to cloud-motion winds. In addition to the VAS, GOES also carry a Data Collection System, for the collection of environmental data from remote observing platforms, and a Space Environment Monitor which provides solar radiation data to NOAA's Space Environment Laboratory.

Polar Orbiting Satellites

NOAA's polar-orbiting satellite system, also called the NOAA or TIROS-N series, collects global observations in support of numerical weather analysis and prediction, flood forecasting, water resource management, fishing, shipping and ocean monitoring services, crop production forecasting and solar activity monitoring. (Figure 7.) The 1983 budget request of $25.641 million for polar spacecraft, launching and ground systems represents a reduction of $24.665 from the FY 1982 base. This request reflects the proposal to reduce polar coverage from a two to a one-spacecraft system with replacement launches planned for 18-month intervals. The request allows for the delay of NOAA H through J spacecraft procurement to FY 1984. We expect to save approximately $271 million in Federal expenditures over the life of the revised polar orbiter spacecraft launch plan (by 1992) while still providing coverage of essential weather information needed by the United States. The requested budget will enable:

- environmental testing and launch of NOAA E;
- fabrication, integration and testing of NOAA D through G;
- sensor procurement for NOAA H through J;
- detail design study to modify NOAA H through J for the Shuttle launch;
- continued refurbishment of Atlas F launch vehicles; and
- improvements in operational effectiveness of the data processing system.

In addition to the amounts requested for weather spacecraft procurement, described above, the budget also contains $41.521 million for weather satellite operations and $6.522 million for supporting research and development. (Figure 8.) The operations budget pays for operation and maintenance of the command and control facilities, including contractor personnel at Wallops Islands, Virginia, and Gilmore Creek, Alaska; satellite field services station operations in Washington, D.C., Miami, Kansas City, San Francisco, Anchorage, Honolulu, and Slidell, Louisiana; and facilities for centralized data processing and analysis. The R&D budget, maintained at the same level as FY 1981-1982, provides research in the development of new and improved methods of obtaining satellite data and more effective uses of the data in environmental monitoring, prediction and warning.

Landsat

NOAA is requesting an FY 1983 appropriation of $14.955 million to support its operation and management of the U.S. Landsat system. However, the total cost of operating Landsat operations in FY 1983 is $24.74 million. (Figure 9.)

NOAA hopes to recover the total cost of Landsat operations from the sale of Landsat data to Federal and non-Federal users. The revenues from non-Federal users collected will be paid into the U.S. Treasury to offset the NOAA appropriation.

The difference between the amount NOAA is requesting and the total Federal government request will be reflected in the budgets of Federal user agencies, including the Department of Agriculture, the Department of Defense, the Department of the Interior, and the CIA. These and other user agencies will reimburse NOAA for their respective shares of the Landsat operating costs. I urge the support of the Members of the Subcommittee in obtaining from your colleagues on other Committees these necessary Federal user agencies' budget requests. The funds will be used to contract for management of the ground system at the Goddard Space Flight Center; to reimburse the Department of Interior's EROS Data Center at Sioux Falls, South Dakota, for the archiving of Landsat data and the provision of retrospective and other data services; and for NESS' management of the program.

Cabinet Council on Commerce and Trade Policy Review

The Cabinet Council on Commerce and Trade is examining two issues pertaining to civil operational satellites:

- What is the best mechanism to implement the policy of transfer of civil land remote sensing systems (Landsat) to the private sector as soon as possible?

- Should we simultaneously transfer to the private sector both civil weather and land remote sensing systems?

The Cabinet Council met on December 16, 1981, to discuss the first issue; consideration of the second issue was temporarily deferred, until Landsat policies are resolved. The Cabinet Council requested additional information on benefits and related costs for Landsat-type data (i.e., what is the long-term Landsat-type data worth to the Federal government and the Nation and how do the benefits compare to the costs). The additional information has been prepared and provided to the Cabinet Council. As soon as the Cabinet Council has reconvened and decided this important issue, I will be glad to share the results with the Members of this Subcommittee. I am confident that in reaching a decision on how to commercialize land remote sensing systems, the element of competition will be a prime consideration.

Landsat Operational Takeover

NOAA is on schedule to assume responsibility from NASA for operation of the new Landsat D system. The Landsat D system is the next generation, dedicated land remote sensing satellite system which is designed to satisfy continuing requirements for timely, accurate and reliable data on the earth's resources. (Figure 10.) We expect that the Landsat D system, with its new higher resolution Thematic Mapper (TM)

experimental new sensor, will improve the ability to locate minerals, oil and gas and other non-renewable resources; to monitor and forecast global crop production; to manage its renewable resources; and to monitor major floods, earthquakes and other natural disasters. (Figure 11.)

Landsat D, which will carry the TM sensor, which is experimental, in addition to the Multispectral Scanner (MSS), which is an operational sensor, is scheduled for launch in July of this year. Landsat D' will be completed in mid-1983 and launched in 1985, assuming no failure of Landsat D. NOAA will assume responsibility for operating the spacecraft and producing Landsat tapes and images as soon as acceptable performance criteria are met for Landsat D, expected to be by January 31, 1983. NOAA will assume responsibility for managing the TM activity in approximately January 1985, after NASA has completed a two-year R&D effort. Incidentally, we expect that TM will provide better coverage of the visible reflected light spectrum than the planned foreign competiors.

We have taken the following specific steps to assure a smooth transition of operating responsibility from NASA to NOAA: (Figure 12.)

- Created a Landsat operations group in NOAA; staffing of this group is now 60 percent complete and it will be fully staffed 6 months before takeover.

- Issued a request for proposals for a contractor to manage the spacecraft command and control and data preprocessing functions at the Goodard Space Flight Center.

- Reached agreement (in principle) with the EROS Data Center on NOAA's management of the data processing, delivery and billing functions at the EROS Data Center; and

- Negotiated with NASA the detailed terms for turning over the spacecraft and ground system to NOAA, including eventual responsibility for TM data, and for continued NASA assistance after the transition.

With NOAA's takeover of Landsat operations, the U.S. will have for the first time a single manager of the Landsat program--from spacecraft command and control to data production and dissemination. (Figure 13.) NOAA will have on-site managers at the EROS Data Center. For the first time we will offer to customers a system of ordering special acquisitions of data for the desired time and place on the earth. This system will allow customers with specific requirements, e.g., field tests, to obtain from the satellite coverage over their particular areas of interest. The Landsat D system is designed to provide preprocessed data to realtime users, such as the Department of Agriculture, within 48 hours. We anticipate that products from the EROS Data Center will be delivered to buyers on a more routine basis than for the current experimental system. To match these new and improved services, NOAA has announced a new

price list for Landsat products effective October 1, 1982. (A copy of the price list is attached to my statement which I will provide for the record.)

NOAA also has advised the eleven foreign ground stations now receiving Landsat data directly that the annual fixed access fees will be increased and that they will have to pay distribution fees based on the type and number of products distributed by station operators. Recovery of the Landsat operating costs will relieve the general taxpayers of the burden of subsidizing specific program beneficiaries. We are in the process of drafting new agreements for these stations to replace existing agreements signed by NASA. These agreements will incorporate the new prices.

To advise NOAA in planning for operational takeover and commercialization of Landsat, we are creating a 15-member non-Federal Land Remote Sensing Satellite Advisory Committee. We are in the process of making final selections for the Committee from the more than 160 nominations received to date. The Advisory Committee is expected to meet in April 1982 and meetings will be open to the public. This Subcommittee will be notified of all meeting dates and the minutes of each meeting will be made available.

Landsat Authorization Legislation

On May 5, 1981, Secretary Baldrige sent the Congress an Administration-proposed bill to authorize Commerce to plan and provide for the management and operation of a civil land remote sensing system and to charge user fees, among other purposes. This bill would authorize $2.1 million for FY 1982 and such sums as may be necessary for FY 1983. Now that the Administration's FY 1983 budget has been transmitted to the Congress, I request that you amend the authorization bill, previously submitted, to incorporate the FY 1983 budget request for Landsat of $14.955 million and pass the amended bill. The Secretary of Commerce has sent a letter to the Congress confirming the Administration's support of this legislation and requesting the necessary technical amendment.

When this legislation is enacted, NOAA will have clear authority to operate the Landsat satellites and to charge fees for Landsat products that recover our operational costs.

After the Cabinet Council concludes its policy review of civil remote sensing satellite commercialization, we anticipate forwarding for your consideration amendments to this legislation. The amendments would establish a process for commercialization of those satellite services which can best be commercialized and likely will include a request for authority to transfer some or all of the government's assets if to do so would be in the best interest of the United States.

NOAA Reorganization

The NOAA Administrator recently announced that he soon will send to the Secretary of Commerce a formal proposal to restructure certain parts of the NOAA organization. (Figure 14.) This restructuring is necessary to: (1) organize NOAA's varying functions more logically; (2) widen communications and coordination throughout the agency; (3) reflect more accurately budget priorities; and (4) reduce administrative overhead. We expect to send our proposal to the Secretary later this month.

In recognition of the close relationship between the satellite data gathering capabilities of the agency (NESS) and our data and information processing and dissemination functions (EDIS), these two activities may be brought together, under a single Assistant Administrator. This new component would provide data and information services to users both inside and outside the agency.

We do not believe that the proposed reorganization will have a significant impact on our operational satellite remote sensing activities.

Mr. Chairman, this concludes my prepared remarks. Thank you for this opportunity to apear before you. I believe that the FY 1983 budget for NOAA's operational satellite services represents a program balanced between the Nation's needs for environmental and land remote

sensing satellite data and services and the need to impose fiscal restraint on the Federal budget. We are moving to transfer to the private sector those activities which can best be carried out there while at the same time maintaining responsibility in the Federal government for activities vital to overall U.S. interests. I will be happy to answer any questions you or the Committee members may have.

December, 1981

NOAA PRICES FOR LANDSAT
DATA, PRODUCTS AND SERVICES
EFFECTIVE OCTOBER 1, 1982

PRODUCTS AND SERVICES	PRICE
Archive	
Imagery Products	
70 mm film positive (B & W)	$ 26.
70 mm film negative (B & W)	32.
10 in. film positive (B & W)	30.
10 in. film negative (B & W)	35.
10 in. paper (B & W)	30.
20 in. paper (B & W)	58.
40 in. paper (B & W)	95.
10 in. film positive (color)	74.
10 in. paper (color)	45.
20 in. paper (color)	90.
40 in. paper (color)	175.
16 mm microfilm (B & W)	60.
35 mm slide (color), from an existing collection	4.
16 mm microfilm (color, 100' roll)	150.
Digital Products	
9-track, 800 BPI CCT; MSS Scene - all available bands	650.
9-track, 1600 BPI CCT; MSS Scene - all available bands	650.
9-track, 800 BPI CCT; RBV (Single-subscene)	650.
9-track, 1600 BPI CCT; RBV (Single-subscene)	650.
9-track, 800 BPI CCT; RBV (set of 4 subscenes)	1300.
9-track, 1600 BPI CCT; RBV (set of 4 subscenes)	1300.
14-track, High Density Tape (variable content)	Variable
Generation of Color Composite (false color IR)-add to product price	195.

Special Acquisition Data and Products

(Special Acquisition signifies Landsat D MSS scene data that are not scheduled for routine collection, but which are provided upon user request.)

Delivery of preprocessed digital data, to the requestor's site via communication satellite; per MSS scene collected at a time and place specified by the requestor ...	790.
Delivery to the requestor of a frame of standard MSS imagery (not a color composite); per MSS scene collected at a time and place specified by the requestor ...	880.
Delivery to the requestor of a computer compatible or high density digital tape; per MSS scene collected at a time and place specified by the requestor ...	$1000.

- OVER -

Special Acquisition Data and Products (cont.)	PRICE
Surcharge for delivery of a color composite to the user originally requesting the special acquisition of an MSS scene; per scene ...	150.
Surcharge applied when the requestor establishes a maximum allowable cloud cover condition for the collection of an MSS scene; per scene ...	250.
Subscription Services	
Landsat microCATALOG	
Annual	
World (Monthly Update)	1088.
North Zone (Monthly Update)	508.
South Zone (Quarterly Update)	290.
Polar Zone (Quarterly Update)	290.
Region 1 (Monthly Update)	139.
Region 2 (Monthly Update)	139.
Region 3 (Quarterly Update)	52.
Region 4 (Quarterly Update)	29.
Region 5 (Quarterly Update)	36.
Region 6 (Quarterly Update)	36.
Region 7 (Quarterly Update)	65.
Region 8 (Quarterly Update)	52.
Region 9 (Quarterly Update)	58.
Region 10 (Quarterly Update)	131.
Current Edition	
World	377.
North Zone	203.
South Zone	102.
Polar Zone	73.
Region 1	58.
Region 2	58.
Region 3	17.
Region 4	14.
Region 5	14.
Region 6	10.
Region 7	14.
Region 8	14.
Region 9	14.
Region 10	36.
microIMAGE Fiche (Landsat D)	Price to
Annual by World, Zones, and Regions	be announced
microCATALOG/microIMAGE Fiche (Landsat D) combination	Price to
Annual by World, Zones, and Regions	be announced

Mr. FLIPPO. We are pleased at this time to receive the testimony of Dr. Cormick who is past Chairman of the Board of Directors of the Geosat Committee. He is assistant manager of advanced exploration of Conoco, Inc.

We are delighted to have you with us. Please feel free to summarize your remarks. Your entire statement will be placed in the record.

STATEMENT OF DR. RONALD K. CORMICK, ADVANCED EXPLORATION GROUP, CONOCO, INC.

Dr. CORMICK. Thank you very much, Mr. Chairman, and members of the committee. I am both honored and pleased to testify before you today in the capacity of representing research scientists, explorationists and the Geosat Committee membership. Prior to my present position, I was manager of Conoco's exploration research division and directed the company's research activities in the area of Earth resource remote sensing.

It was during that time and in that role that I had to watch this great Nation lose its grip on the preeminent position in civil remote sensing technology and degrade to the shambles of the nonprogram that we must review today. Unfortunately, it is just one more example of a scenario played out in several other U.S. industries.

Coincident with the decline in commitment by the U.S. Government is an increase in commitment by several foreign governments because today this country has no system which insures that global multispectral data will be delivered to the user in a regular, timely manner and optimized format.

However, even more serious is the decline and, in fact, demise of research and development in the nonrenewable resource area by NASA due to this same lack of long-term commitment, straightforward government policy, and executive leadership.

As my written statement says, having said all that, not only to get your attention but perhaps your consternation, I will try to summarize the remainder of my statement. Before I do, to make sure we are communicating on the same wavelength as far as terms, when we refer to the public sector, we usually identify that as the Federal Government and other levels of governmental agencies from States and on down. The private sector we normally refer to as industry, which can include individual citizens and groups, engaged in activities for monetary return.

In our application area we typically recognize industry as three distinct groups: The aero-space remote sensing industry which builds the sensor systems, platforms, and the ground data processing facilities; the value-added industries which usually provide the hardware, the software, and the analytical techniques for utilizing remote sensing data; and the end-user industries which utilize remote sensing data to solve technical problems and also are, quite often, involved in the development of hardware and software.

I will try to represent all three. I feel more comfortable representing the third. The items that I will try to summarize are: The issue of remote sensing utilization of the Landsat data; the issue of operational versus research and development systems. I will try

and explain who is and should be responsible, from our point of view; the policy issues that we feel are blocking private sector involvement; why we will purchase French and Japanese remote sensing data; how important data and program continuity is to us; and why NASA or NOAA should follow through with Landsat D' at least.

Remote sensing utilization is an established technique utilized in exploration and engineering and environmental geology. The previous Landsat programs have provided us with excellent data from a limited portion of the electromagnetic spectrum. With the advent of the Thematic Mapper scheduled to fly on Landsat D, hopefully in 1982, we will suddenly have access to data which can spectrally discriminate rocks and soils and probably various types of vegetation for superior application to earth science problems as well as agriculture, timber, and land-use planning.

Results from the joint NASA/JPL/Geosat Test Case Program indicate the Geosat Committee that Landsat D thematic mapper data may be the most useful data yet to be provided to the geological community from satellite remote sensing systems. However, such a program is clearly experimental in nature, both for NASA and for the user community. It will be a first.

You must understand that information acquired by the Landsat D system, even at its best, cannot be expected to replace the drill bit. Information acquired by satellite remote sensing is of incremental importance to the user community in oil and gas exploration. It can be expected to improve the overall quality of our best guess and expedite our global search for nonrenewable resources. But, we do not expect it to find these resources without terrestrial data. Therefore, although we espouse the benefits of such an experimental system, we are nevertheless aware that it is indeed an experimental system in nature and is relatively untested and that it is of incremental importance to the user. Unlike the communications business where only a few companies dominate the field, the natural resources community is a varied and large user community. When one aggregates the incremental benefits of such a large user community, one can easily conclude that the satellite remote sensing program is indeed extremely beneficial to this Nation's economy and national security in its aid to the search for strategic resources. For these reasons, it is the conviction of the Geosat Committee, and myself, in particular, that unless the U.S. government flies Landsat D and, at least, D' as a follow-up to its preliminary experiment, the private sector will not step in to sponsor in total such a program. The loser in such a situation will be the United States, and I am personally convinced that such a loss is totally contrary to the stated policies and goals of the Reagan administration.

Now, the issue of operational versus research and development systems and who should be responsible for what portion. Tony and I have had our discussions on that in the past. It is my understanding that this is the item of primary concern to the committee today. I believe the question of whether NASA should be involved in operational systems is moot. NASA has been involved with operational systems for a considerable period of time. And, as Mike Halbouty eloquently stated to this committee last year:

It is obvious to us that when the MSS—the multispectral scanner—operated successfully on Landsat 2, that portion of the system should have been designated operational. In so doing we would have stimulated private sector involvement and industry participation would have been a reality today.

Unfortunately, the issues have been complicated and confused from that point on, and today NOAA has the responsibility without adequate funds, NASA has the systems without the research and development follow-up and without a commitment of follow-through. Because NASA has believed its mandate to be only research and development it has ignored the fact that many of its programs are operational; and as a result, the ground segment portion has been and is poorly designed and funded. The end user is unable to receive routinely the timely data he needs.

To summarize that point: (a) we are involved with frontier technology, (b) any time one develops new technology some portions become routine or operational while other portions must continue to be developed, (c) NASA should quit hiding behind its pristine research and development myth and begin working directly with private industry, (d) government must resolve policy problems to permit private sector involvement at the earliest possible point in operational technology, (e) research by both NASA and private industry must continue to evolve new technology and science in this area, (f) any additional federal agencies involved with the civil land remote sensing program serves only to proliferate government bureaucracy and increase government spending, neither of which are acceptable to the Reagan administration nor the user community, (g) change NASA's charter if that is what is necessary to bring it up to date with respect to research and development and operational responsibility, (h) consider seriously the consolidation of other remote sensing efforts back into the same singular agency, and (i) face the reality that if the U.S. government drops out of the operational earth remote sensing satellite program after LANDSAT D or D' without developing private sector involvement or generating policy and proprietary data safeguards, then the United States becomes dependent upon the goodwill of foreign nations who are developing their own programs. Even if they are willing to share their data, obviously this infers negative balance of payments as the United States buys their data and an increased dependency on foreign governments. I will stress here that the key to industrial involvement is that element of financial risk; in other words, the key issue is who controls the data. For example, if private industry were responsible for the ground segment of the existing Landsat programs, it would be out of business by now if it conducted itself in the manner in which the Government has operated. That is, there is substantial financial risk in the marketplace when a company fails in meeting obligations. The user community expects efficient and effective handling of its requests on a value basis. In other words, the service company would not survive if it provided the type of service that NASA/Goddard and EDC provide. However, the service company would only consider such an enterprise under guarantees of data distribution from the Federal agency to the ground segment on an agreed upon, timely basis.

The poorly coordinated, and indeed, current confusion in the roles of NASA, NOAA, and the EDC, plus the lack of an effective

institutional framework, are causing severe detrimental effects on the planning of an operational system and for the growth in utilization of remote sensing data. Designation of a lead agency such as NASA is critical. That lead agency must speak for the entire aggregated Government market end user groups. Areas of participation and definition of private sector responsibilities to best serve the U.S.'s interests are not yet defined. There are no mechanisms yet developed for cooperative effort between government and industry, and that is appalling. Certainly, all other industrialized countries participating in satellite remote sensing development in the critical area of energy/mineral resource exploration that the Geosat Committee has visited have such mechanisms.

I will move on to the next item: The major policy issues blocking private sector involvement. I have tried to identify those for the benefit of this committee: (a) civil land remote sensing satellite systems cannot operate in the private sector in competition with Federal subsidization and/or data for the cost of reproduction without some acceptable, cooperative venture. This is true whether it be the U.S. Government or the French, Japanese, or some other nation who would provide similar data at virtually no cost; (b) assuming that U.S. Government control ends at the end of LANDSAT D', it is imperative that any follow-on system operated by the private sector have the approval, endorsement, and international protection of the U.S. Government in dealing with all past and present signers of international space laws and agreements of which the United States is part; (c) for any private sector investment effort, it is critical that the issue of reclassification of military surveillance data be resolved. The Geosat Committee worked on this problem with the previous administration and is presently working with the Reagan administration. A clear-cut statement concerning the release or nonrelease of these data is vital to the decisions of any corporate group concerning investment in an operational system; (d) for those portions that are economically viable, the proper government/private sector relationship should be well-defined to quickly remove them to the private sector as the most efficient way of operating the systems. Those areas that are properly within government sectors and services, such as State and local governments, academia, and other special national interests, et certera, which cannot be provided economically or appropriately by the private sector should be retained within government; (e) nonprofit organizations, such as universities, must find their own role in evolving private sector development for data because the costs will increase. They must be expected to pay their fair share, and if they are to be subsidized, it will be through the acquisition of adequate funds rather than the provision of cheaper data. In the latter case, this would obviously undermine the economic viability of any enterprise; (f) international cooperation becomes critical as private industry becomes involved in the development of operational systems. Obviously, the best course we could follow is to cooperate in the international community to create complimentary, compatible systems.

It is my considered opinion that if the United States drops out of the LANDSAT program, either through a conscious effort to do so or by inadequately addressing the issues articulated above with no

development of private sector involvement in the United States, then it is most likely that the French, Japanese, and other foreign national systems may not cooperate in "Open Skies" accessability and availability of data to all users. That is, we cannot assume that foreign nations are motivated to serving the needs of the United States in an equitable manner.

Now I will move on to the issue of why we would purchase their data. As previously discussed, the user community is well-represented by government agencies, individuals, and corporations. In every case, unless prohibited, we can be expected to seek wherever available the products necessary for accomplishing a given job. Just as NASA buys word processing systems built by the Japanese so will they, or other agencies, buy their remote sensing data if it will serve a useful purpose. We, in the nonrenewable resource industry, understand at this time that the French and Japanese programs are designed to provide useful data to aid in solving technical resource problems. If such data are made available at an affordable/cost-effective price, then they will be purchased. This is the manner in which foreign nations have purchased LANDSAT data from the United States because these foreign nations recognize, as we do, the frontier opportunities which civil satellite remote sensing represents in all areas, including nonrenewable resource exploration. They have copied and/or improved upon U.S.technology to fund their own civil satellite remote sensing programs. They have specific objectives in mind, some of which adequately overlap with our own. Remember, if you will, that originally the LANDSAT program was designed and implemented without the input or involvement of all user communities. It is because we will use whatever can possibly give us a competitive edge that caused us to become the major private sector purchaser of LANDSAT data; not because it is ideally suited.

If leadership in space technology is more than a dream in the minds of a few in Government, such as Senator Harrison (Jack) Schmitt, then I strongly recommend to this committee that you seriously review the dangerous precedents you are initiating or endorsing through the massive cutback in civil remote sensing satellite programs. I cannot believe anyone here thinks the steps which have been taken in the last year and a half are in the national interest. My discussions and presentations with and to the public at large on this topic convince me that an informed public would concur with me when I strongly suggest that you preserve and improve the Federal commitment to the LANDSAT program.

Now, the item on program and data continuity and how important they are. Remember, first of all, that I do not adequately represent the agriculture or timber community, although this question appears to be moot when I look at the proposed Government spending effort and lack of coordinated effort among NASA, NOAA, EDC, and the private sector. In other words, it looks to me like we have continuity problems built in. I will, nevertheless, seek to address this issue.

The problem of data continuity is far more critical to the renewable resource industries than the nonrenewable. In the case of the latter industries, we do benefit from seasonal differences as portrayed on LANDSAT scenes, but the geology changes very slowly

through man's short span of geological time, and therefore, our concerns are in the area of program continuity. There are gaps in the NASA program and you can reasonably expect that competitor nations will look carefully at the market opportunities these gaps represent. This is especially true if the gaps occur because of a lack of follow-on research and development by NASA. It is critically important for this committee to recognize the need for adequately funding longer-term, high-risk, but potentially high-payoff, fundamental research and technical development; especially to capitalize on the tremendous technological advantage that the Space Shuttle provides. After billions of American tax dollars have been successfully invested in the Space Shuttle development program, it appears incongruous from my perspective to now turn our backs on this major technological breakthrough opportunity.

NASA programs related to instrument development and testing of Earth observation payloads in the Shuttle have become extinct through lack of funds. Such an opportunity occurs once or twice in your lifetime or mine, and during a period of time when this Nation desperately needs to recover its technological advantage we are failing to exploit it. This is really an incredible oversight by the U.S. Government and insures that we will become less competitive in aerospace remote sensing, especially in the applications of remote sensing techniques and acquired data to our own resource problems. I would emphasize here that the incentives here are national-interest incentives and not private enterprise financial incentives, and therefore will generate a competitive response only by foreign national concerns. Can the United States afford to ignore such a superb opportunity and cause one more case of technological inferiority to develop? That, gentlemen, is a question which you must answer and for which answer you will be held accountable.

The next item is why NASA programed LANDSAT D, from our point of view.

As we discussed previously, LANDSAT D with its improved resolution and on-board thematic mapper is experimental in any man's language. To NASA, it is so experimental that the distribution of scenes will be extremely limited to only principal investigators for a considerable period of time and that, Mr. Chairman, is a point that I would ask that you consider in light of Dr. Calio's comments relating to the private sector paying back cost for operating LANDSAT D. Only a few scenes per year will be accumulated during its lifetime according to original plans. The information so obtained will determine what modifications, if any, must be made to the follow-on LANDSAT D′ system. This committee must recognize the risk involved with LANDSAT D concerning its ability to collect high-quality TM data. In other words, we cannot assume that LANDSAT D will work perfectly and that, therefore, LANDSAT D′ is unnecessary.

It is also wrong, from our perspective, to assume that LANDSAT D will be a failure and that only a small number of scenes need, therefore, to be utilized. Rather, we strongly recommend that this committee consider adequate funding of the LANDSAT D/TM program to acquire as many scenes as possible and to adequately archive these data for future access. Obviously, these are contingency

dollars which would not be spent if the LANDSAT D system failed. On the other hand, if it were a total success, then full acquisition of available scenes would permit NASA and OMB to re-evaluate the status of LANDSAT D' and potentially speed up the transition of an operation system to the private sector.

In a memo from NOAA, dated December 1981, we are told that the user community has the opportunity to request additional scenes from LANDSAT D. Recently, we had the opportunity to see NOAA's budgeting for such an effort. Gentlemen, the question is, therefore, will adequate funds indeed exist or do we have another example of a nonfulfillable promise. Our previous experience in this area with NASA's LANDSAT programs and data deliverability have been less than acceptable. But this is simply a symptom of a problem which I strongly recommend that you address and solve if you really wish to establish credibility for future transfer of technology to the private sector.

To summarize, I make the following comments and recommendations:

First. The utilization of satellite remote sensing data in the nonrenewable resource industry is in either its infancy or early childhood. It is a frontier area of technology whose opportunities are only beginning to be realized; whose impact on the national economy and national security cannot be under-emphasized.

Second. The state of affairs of the LANDSAT program in the United States today is, quite bluntly, chaos and disarray.

Third. In spite of a system designed for other applications, a ground distribution system and organization which has never provided rapid, timely access to the data, and an agency that hides behind its supposed pure research and development role, the data provided by LANDSAT 1, 2, and 3 are making a substantial contribution to this Nation's efforts in solving its strategic resource problems.

Fourth. There are many aspects of the LANDSAT program which are adequately operational today for transfer to the private sector. In fact, it is overdue.

Fifth. There are numerous policy and institutional issues which must be resolved before the private sector can become a viable partner.

Sixth. There must be continuity of the program and related research and development which fall within the realm of Government responsibility. Indeed, the high-risk, but high-payoff, remote sensing research and development represent a tremendous opportunity with respect to the Space Shuttle. This could be a national tragedy if overlooked.

Seventh. A singular agency should become the focal point within the Government for both research and operations of satellite systems in order for effective coordination to occur among that agency, other Government agencies, and the user community.

Eighth. Funding commitments must be made immediately to insure on a contingency basis that all potentially usable scenes be collected by LANDSAT D/TM and archived for future user access.

Ninth. Reclassification of military surveillance data has been a cloud over all decisions regarding civil remote sensing programs, just ask OMB. It must be resolved before private industry would

get involved because the potential market could be erased. Also, there may be data that are important to the national interests only if released for utilization rather than gathering dust.

Tenth. A special advisory committee or board needs to be convened immediately to aggregate the needs of the broad and diverse user industries and Government agencies.

Eleventh. International cooperation is now a necessity because the United States will rapidly become dependent upon foreign sources for satellite remote sensing data.

Twelfth. Joint research between industry and Government, such as the NASA/JPL-Geosat test case program, can be very productive and involves millions of dollars directly invested by Geosat member companies.

Thirteenth. More input is recommended by the end-user community to this and associated committees.

Thank you, Mr. Chairman and members of the committee, for the opportunity to speak with you today.

[The prepared statement of Dr. Cormick follows:]

Statement

of

Ronald K. Cormick

before the

House of Representatives

Committee on Science and Technology

Special Hearing on Landsat Program Budget in NOAA and NASA

March 3, 1982

Washington, D. C.

Ronald K. Cormick

Past-Chairman of the Board of Directors

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STATEMENT

Mr. Chairman and Members of the House Committee on Science and Technology, I am both pleased and honored to testify before you today in the capacity of representing research earth scientists, explorationists, and The Geosat Committee membership. Prior to my present position, I was Manager of Conoco's Exploration Research Division and directed the company's research activities in the area of earth resource remote sensing. It was during that time and in that role that I had to watch this great nation loose its grip on the preeminent position of civil remote sensing technology and degrade to the shambles of the nonprogram that we must review today. Unfortunately, it is just one more example of a scenario played out in several other U.S. industries. Coincident with the decline in commitment by the U.S. government is an increase in commitment by several foreign governments because today this country has no system which insures that global multispectral data will be delivered to the user in a regular, timely manner and optimized format. However, even more serious is the decline and, in fact, demise of research and development in the nonrenewable resource area by NASA due to this same lack of long-term commitment, straightforward government policy and executive leadership.

Having said all that, and getting not only your attention but perhaps in some cases, your consternation to mentally ask what I am willing to do about it, I will now proceed to clarify my vantage point as a representative of industry; what we think needs to be done to preserve a U.S.-based operational Landsat program. So that we are communicating with similar terms and their meanings, please indulge me while I clarify some of the terms that I will be using frequently. To the resource industry, the public sector is identified as federal and other government agencies. The private sector, which we normally refer to as industry, includes citizens, both individual and as groups, engaged in activities for monetary return. In the civil remote sensing arena we typically recognize the industry as containing three distinct groups which are: (1) the aero-space remote sensing industry which builds space platform sensors and ground data processing facilities; (2) the value-added industries which provide the hardware, software, and analytical techniques for utilizing remote sensing data; and (3) the end-user industries which utilize remote sensing data to solve technical problems.

On behalf of The Geosat Committee I will attempt to represent all three groups and on behalf of Conoco I will attempt to represent the third group.

- Remote Sensing is an established technique utilized in exploration engineering and environmental geology. LANDSATS 1-3 have provided

us with excellent data in the 0.4 to 1.1 microns portion of the electromagnetic spectrum. With the Thematic Mapper (TM) scheduled to fly on LANDSAT D in late 1982, we will suddenly have access, hopefully, to data which can spectrally discriminate rocks and soils and probably various types of vegetation for superior application to earth science problems as well as agriculture, timber, and land-use planning.

I will not attempt here to detail the differences between the LANDSAT D program as presently planned and previous Landsat programs. I am sure that previous testimony from NASA personnel has adequately covered this. For industry's part, let me emphasize that the improvements from the MSS (narrow band-width) data collected in previous Landsat missions is expected to be profound in the LANDSAT D data. For the past few years a joint project among NASA, JPL, and The Geosat Committee has been conducted to evaluate multiple sensor capabilities over various earth resource targets. Included in this project was an evaluation of airborne Thematic Mapper data in light of its potential inclusion on LANDSAT D. Results from the Test Case Program indicate to The Geosat Committee that LANDSAT D/TM data may be the most useful data yet to be provided to the geological community from satellite remote sensing systems. However, such a program is clearly experimental in nature, both for NASA and for the user community. This contrasts with previous Landsat missions wherein the user community would certainly conclude that LANDSAT 3 was operational in nature. Details concerning the results of the Test Case Program have been presented to this Committee in previous testimony by Dr. Frederick B. Henderson, III, President, The Geosat Committee, and perhaps by NASA personnel themselves. Later in the summer, a final report will be published documenting all of the results of that program. You must understand, however, that such information as acquired by the LANDSAT D system, even at its best, cannot be expected to replace the drill bit. That is, information acquired by satellite remote sensing is of incremental importance to the user community in exploration. It can be expected to improve the overall quality of our best guess and expedite our global search for nonrenewable resources. But, we do not expect it to find these resources by itself. Therefore, although we espouse the benefits of such an experimental system, we are nevertheless aware that it is (a) experimental in nature and relatively untested, and (b) of incremental importance to each individual user. Unlike the communications business where a few companies dominate the field, the natural resource community is populated by a very large number of big and small users. When one aggregates the incremental benefits of such a large user community, one can easily conclude

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that the satellite remote sensing program is indeed extremely beneficial to this nation's economy and national security in its aid to the search for strategic resources. For these reasons, it is the conviction of The Geosat Committee, in general, and myself, in particular, that unless the U.S. government flies LANDSAT D and, at least, D'as a follow-up to its preliminary experiment, the private sector will not step in to sponsor in total such a program. The loser in such a situation will be the United States, and I am personally convinced that such a loss is totally contrary to the stated policies and goals of the Reagan administration.

Operational versus R&D Systems - Who should be responsible for what portion? It is my understanding that this is the item of primary concern to the Committee today. I believe the question of whether NASA should be involved in operational systems is moot. NASA has been involved with operational systems for a considerable period of time.

From the user point of view, the LANDSAT systems 1-3, using the multispectral scanner (MSS), have provided data that have been applied routinely to a wide variety of resource problems. As Mike Halbouty has so eloquently stated in previous testimony, it is obvious to us that when the MSS operated successfully on LANDSAT II, that portion of the system should have been designated operational. In so doing, we would have stimulated private sector involvement and industry participation would have been a reality today. However, the previous administration has confused and complicated the issues of operational civil remote sensing systems by assigning the responsibility for a transition to operational status to the Department of Commerce (NOAA). In our evaluation of this transition plan and drafted legislation, we saw the opportunity for private sector involvement being slowed or deferred for perhaps decades. Today, NOAA has the responsibility without the funds and NASA has the systems without the R&D follow-up and without a commitment to follow through. Because NASA has believed its mandate to be only R&D it has ignored the fact that many of its programs are operational; and as a result, the ground segment portion is poorly designed and funded. The end user is unable to receive routinely the timely data he needs. To summarize this point, (a) we are involved with frontier technology, (b) any time one develops new technology some portions become routine or operational while other portions must continue to be developed, (c) NASA should quit hiding behind its pristine R&D myth and begin working directly with private industry, (d) government must resolve policy problems to permit private sector involvement at the earliest possible point in operational technology, (e) research by both NASA and private industry must continue to evolve new

technology and science in this area, (f) any additional federal agencies involved with the civil land remote sensing program serves only to proliferate government bureaucracy and increase government spending, neither of which are acceptable to the Reagan administration nor the user community, (g) change NASA's Charter if that's what's necessary to bring it up to date with respect to R&D and operational responsibility, (h) consider seriously the consolidation of other remote sensing efforts back into this same singular agency, (i) face the reality that if the U.S. government drops out of the operational earth remote sensing satellite program after LANDSAT D or D' without developing private sector involvement or generating policy and proprietary data safeguards, then the U.S. becomes dependent upon the good will of foreign nations who are developing their own programs. Even if they are willing to share their data, obviously this infers negative balance of payments as the U.S. buys their data and increased dependency on foreign governments.

To expand on this overall issue of operational systems responsibility let me begin by assuring you that The Geosat Committee and private industry, in general, have supported from the beginning the development of private sector involvement. However, these efforts have been seriously impaired by the lack of institutional arrangements to permit, or even encourage, such involvement. The situation is further complicated by the fact that amongst all of these complex issues, an operational civil remote sensing satellite system must serve both private industry and government. I should stress here that the key to industrial involvement is the element of financial risk. In other words, the key issue is who controls the data. For example, if private industry were responsible for the ground segment of the existing Landsat programs, it would be out of business by now if it conducted itself in the manner in which the government has operated. That is, there is substantial financial risk in the market place when a company fails in meeting obligations. The user community expects efficient and effective handling of its requests on a value basis. In other words, the service company would not survive if it provided the type of service that NASA/Goddard and EDC provide. However, the service company would only consider such an enterprise under guarantees of data distribution from the federal agency to the ground segment on an agreed upon, timely basis.

The poorly coordinated, and indeed, current confusion in the roles of NASA, NOAA, and the EROS Data Center, plus the lack of an effective institutional framework, are causing severe detrimental effects on the planning of an operational system and for the growth

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in utilization of remote sensing data. Designation of a lead agency such as NASA is critical. And, that lead agency must speak for the entire aggregated government market end user groups. Areas of participation and definition of private sector responsibilities to best serve the U.S.'s interest are not yet defined. There are no mechanisms yet developed for cooperative effort between government and industry, and that is appalling. Certainly, all other industrialized countries participating in satellite remote sensing development in the critical area of energy/mineral resource exploration that the Geosat Committee has visited have such mechanisms. This might take the form of a joint venture, private sector serving as a government contractor or the federal government serving the private sector. Regardless, it is our observation after many years of work in this field, that much of the effort in the remote sensing area can, and should, be moved to the private sector as the most efficient means of providing data services, keeping the needs of the small user well in mind.

The major policy issues blocking private sector involvement. The following issues must be resolved immediately: (a) Civil land remote sensing satellite systems cannot operate in the private sector in competition with federal subsidization and/or data for the cost of reproduction without some acceptable, cooperative venture. This is true whether it be the U.S. government or the French, Japanese, or other nation who would provide similar data at virtually no cost. (b) Assuming that U.S. government control ends at the end of LANDSAT D', it is imperative that any follow-on system operated by the private sector have the approval, endorsement, and international protection of the U.S. government in dealing with all past and present signers of international space laws and agreements of which the U.S. is part. (c) For any private sector investment effort, it is critical that the issue of reclassification of military surveillance data be resolved. The Geosat Committee worked on this problem with the previous administration and is presently working with the Reagan administration. A clear-cut statement concerning the release or nonrelease of these data is vital to the decisions of any corporate group concerning investment in an operational system. (d) For those portions that are economically viable, the proper government/private sector relationship should be well-defined to quickly remove them to the private sector as the most efficient way of operating the systems. Those areas that are properly within government sectors and services, such as state and local governments, academia, upon special natural interests, etc., which cannot be provided economically, or appropriately, by the private sector should be retained within government. (e) Nonprofit organizations, such as universities, must find their own role in an

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evolving private sector development for data because the costs will increase. They must be expected to pay their fair share, and if they are to be subsidized, it will be through the acquisition of adequate funds rather than the provision of cheaper data. In the latter case, this would obviously undermine the economic viability of any enterprise. (f) International cooperation becomes critical as private industry becomes involved in the development of operational systems. Obviously, the best course we could follow is to cooperate in the international community to create complimentary, compatible systems. All interested countries would be involved in building cooperative data base systems, satellite systems, and data distribution systems to minimize cost and unnecessary duplication. It would be in the best interest of the world and, therefore, of the U.S. if these evolving systems were shared under the "Open Skies" concept and were not to evolve into nationalistically competitive systems.

It is my considered opinion that if the U.S. drops out of the Landsat program, either through a conscious effort to do so or by inadequately addressing the issues articulated above with no development of private sector involvement in the United States, then it is most likely that the French, Japanese, and other national systems may not cooperate in "Open Skies" accessability and availability of data to all users. That is, we cannot assume that foreign nations are motivated to serving the needs of the United States in an equitable manner.

Those of us who have looked at the issue of joint ventures between government and industry conclude that massive new legislation is not required for the development of a contractual relationship between an industry entity and government to provide services in the civil land remote sensing area.

U.S. Purchase of French and/or Japanese Remote Sensing Data by Companies, Individuals, and Governmental Agencies. Why?
As previously discussed the user community is well represented by government agencies, individuals, and corporations. In every case, unless prohibited, we can be expected to seek wherever available the products necessary for accomplishing a given job. Just as NASA buys word processing systems built by the Japanese so will they, or other agencies, buy their remote sensing data if it will serve a useful purpose. We, in the nonrenewable resource industry, understand at this time that the French and Japanese programs are designed to provide useful data to aid in solving technical resource programs. If such data are made available at an affordable/cost-effective price, then they will be purchased. This is the manner in which foreign nations have purchased Landsat data

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from the U.S. because these foreign nations recognize, as we do, the frontier opportunities which civil satellite remote sensing represents in all areas, including nonrenewable resource exploration. They have copied and/or improved upon U.S. technology to fund their own civil satellite remote sensing programs. They have specific objectives in mind, some of which adequately overlap with our own. Remember, if you will, that originally the Landsat program was designed and implemented without the input or involvement of all user communities. It is because we will use whatever can possibly give us a competitive edge that caused us to become the major private sector purchaser of Landsat data.

If leadership in space technology is more than a dream in the minds of a few in government, such as Senator Harrison H. Schmitt, then I strongly recommend to this Committee that you seriously review the dangerous precedents you are initiating or endorsing through the massive cutback in civil remote sensing satellite programs. I cannot believe anyone here thinks the steps which have been taken in the last year and a half are in the national interest. My discussions and presentations with and to the public at large on this topic convince me that an informed public would concur with me when I strongly suggest that you preserve and improve the federal commitment to the Landsat program.

Program and Data Continuity - How important are they?
Although this question appears to be moot when I look at the proposed government spending effort and lack of coordinated effort among NASA, NOAA, EDC, and the private sector, I will nevertheless seek to address this issue. The problem of data continuity is far more critical to the renewable resource industries than the nonrenewable resource industries. In the case of the latter industries, we do benefit from seasonal differences as portrayed on Landsat scenes, but the geology changes very slowly through man's short span of geological time, and therefore, our concerns are in the area of program continuity. If there are gaps in the program, you can reasonably expect that competitor nations will look carefully at the market opportunities these gaps represent. This is especially true if the gaps occur because of a lack of follow-on research and development by NASA. It is critically important for this Committee to recognize the need for adequately funding longer-term, high-risk, but potentially high-payoff, fundamental remote sensing research and technology development; especially to capitalize on the tremendous technological advantage that the space shuttle provides. After billions of American tax dollars have been successfully invested in the space shuttle development program, it appears incongruous from my perspective to now turn our backs on the this major technological breakthrough opportunity. NASA

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programs related to instrument development and testing of earth observation payloads in the shuttle have become extinct through lack of funds. Such an opportunity occurs once or twice in your lifetime or mine, and during a period of time when this nation desperately needs to recover its technological advantage we are failing to exploit it. This is really an incredible oversight by the U.S. government and insures that we will become less competitive in aero-space remote sensing, especially in the applications of remote sensing techniques and acquired data to our own resource problems. The incentives are national-interest incentives, not private industry/financial incentives, and therefore will only generate a competitive response by foreign-national concerns. Can the U.S. afford to ignore such a superb opportunity and cause one more case of technological inferiority to develop? That, gentlemen, is a question which you must answer and for which answer you will be held accountable.

There must be a reason why NASA programmed LANDSAT D' - What is it? As we have discussed previously, LANDSAT D with its improved resolution and on-board Thematic Mapper is experimental in any man's language. To NASA, it is so experimental that the distribution of scenes will be extremely limited to only principal investigators for a considerable period of time. Only a few scenes per year will be accumulated during its lifetime according to original plans. The information so obtained will determine what modifications, if any, must be made to the follow-on LANDSAT D' system. This Committee must recognize the risk involved with LANDSAT D concerning its ability to collect high-quality TM data. In other words, we cannot assume that LANDSAT D will work perfectly, and therefore, LANDSAT D' is unnecessary.

It is also wrong, from our perspective, to assume that LANDSAT D will be a failure and that only a small number of scenes need, therefore, to be utilized. Rather, we strongly recommend that this Committee consider adequate funding of the LANDSAT D/TM program to acquire as many scenes as possible and to adequately archive these data for future user access. Obviously, these are contingency dollars which would not be spent if the LANDSAT D system failed. On the other hand, if LANDSAT D/TM were a total success, then full acquisition of available scenes would permit NASA and OMB to re-evaluate the status of LANDSAT D' and potentially speed up the transition of an operational system to the private sector.

In a memo from NOAA, dated December, 1981, we are told that the user community has the opportunity to request additional scenes from LANDSAT D. Recently, we had the opportunity to see NOAA's budgeting for such an effort. Gentlemen, the question is,

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therefore, will adequate funds indeed exist or do we have another example of a nonfulfillable promise. Our previous experience in this area with NASA's Landsat programs and data deliverability have been less than acceptable. But this is simply a symptom of a problem which I strongly recommend that you address and solve if you really wish to establish credibility for future transfer of technology to the private sector.

In summary, I make the following comments and recommendations:

(1) The utilization of satellite remote sensing data in the nonrenewable resource industry is in either its infancy or early childhood. It is a frontier area of technology whose opportunities are only beginning to be realized; whose impact on the national economy and national security cannot be underemphasized.

(2) The state-of-affairs of the Landsat program in the United States today is, quite bluntly, chaos and disarray.

(3) Inspite of a system designed for other applications, a ground distribution system and organization which has never provided rapid, timely access to the data, and an agency that hides behind its supposed pure R&D role, the data provided by LANDSAT 1,2 and 3 are making a substantial contribution to this nation's efforts in solving its strategic resource problems.

(4) There are many aspects of the Landsat program which are adequately operational today for transfer to the private sector. In fact, it is overdue.

(5) There are numerous policy and institutional issues which must be resolved before the private sector can become a viable partner.

(6) There must be continuity of the program and related R&D which fall within the realm of government responsibility. Indeed, the high-risk, but high payoff, remote sensing research and development represent a tremendous opportunity with respect to the space shuttle. This could be a national tragedy if overlooked.

(7) A singular agency should become the focal point within the government for both research and operations of satellite systems in order for effective coordination to occur among that agency, other government agencies, and the user community.

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(8) Funding commitments must be made immediately to insure on a contingency basis that all potentially usable scenes be collected by LANDSAT D/TM and archived for future user access.

(9) Reclassification of military surveillance data has been a cloud over all decisions regarding civil remote sensing programs. It must be resolved before private industry would get involved because the potential market could be erased. Also, there may be data that is important to the national interests only if released for utilization rather than gathering dust.

(10) A special Advisory Committee/Board needs to be convened immediately to aggregate the needs of the board and diverse user industries and government agencies.

(11) International cooperation is now a necessity because the U.S. will rapidly become dependent upon foreign sources for satellite remote sensing data.

(12) Joint research between industry and government, such as the NASA/JPL-Geosat Test Case Program, can be very productive and involves millions of dollars directly invested by Geosat member companies.

(13) More input is recommended by the end-user community to this and associated committees.

Thank you, Mr. Chairman and Members of the Committee, for the opportunity to talk with you today.

Mr. FLIPPO. Dr. Cormick we are delighted to receive your testimony this morning. It was very thought-provoking and points out many areas that need to have much further debate upon. I know that you have observed the administration's representations to this committee in the form of their budget request and I am sure that you are familiar with the history of the committee, in that this committee seems certainly to agree with your point of view in regard to inadequate exploitation of space and of the capabilities that we have had in the past.

I wonder if this budget situation and the testimony in regard to the NASA budget and the NOAA budget gave you any confidence that we are going in the right direction? Or, perhaps, what should we be doing differently? What should Congress be doing differently?

Dr. CORMICK. Well, I concentrated in the testimony on the issue of a singular agency. I think that is something you should be doing differently. I think that could be expeditious, not only in cost-effective use of Government funds but also in the interaction with private enterprise. That is one major area.

The total funding of the LANDSAT program that appears to be coming through is inadequate for any distribution of data on a timely basis; that is simply not provided for, it has never been provided for. This resulted primarily because the ground segment has been poorly defined, poorly set up; because it was only supposed to be an experimental research and development effort.

Even under the operational guides that appear to be evolving we in the user community are not confident at all that there will be an adequate change in the ground segment. As long as those data are impossible to get your (my) hands on, you are wasting your (the Nation's) funds.

Mr. FLIPPO. The present NASA plan is to phase out support for development of an operational system and to concentrate on research and development of improved sensors, higher resolution, and in increased data rate. Many segments of the customer community apparently have not yet decided that the present resolution and data rate are worth the cost. Improved resolution and increased data will certainly increase the costs of processed data per frame or per unit area. For example, going from 40 meters to 20 meters resolution, some have testified, would raise the cost four times. Under these circumstances, do you think that it is rational for NASA to concentrate on refining and improving present capabilities rather than completing the present LANDSAT experiment and demonstrating and evaluating that work?

Dr. CORMICK. Well, that is a complicated question and it might cause a complicated answer. But, to take the part, first of all, that the existing LANDSAT program has limited resolution and limited band-width. The thematic mapper addition will make a very substantial improvement in the use of LANDSAT data for the whole user community, and I am sure that is true for the agriculture and timber areas as well as the nonrenewable resource industry. So, they have already addressed one major issue from that vantage point, of improved data quality. There are improvements that could be made and if those improvements were made they would have a substantial impact on embracing new user communities. For in-

stance, the engineering area cannot possibly use LANDSAT data because the resolution is too poor and the 20 meters will not accomplish it either. So, you are talking more like the French SPOT system which is intended to be a 10-meter resolution. That is getting close to what is needed by the very large user community represented by engineering firms, the land use planning firms, or, to be more specific, the coal industry which does its mine planning using data/images from airborne systems. They would make excellent use of that high-quality data in all of their mine planning. But, that will not be encompassed by, at least the anticipated improvements, in the LANDSAT resolution.

Now, the statement concerning data rates and processing, I would disagree with. I think, for instance, to be very specific, that the 64K chip, which unfortunately is probably going to be developed by Hitachi or somebody else before the United States can get it into operation, will have a profound effect on the overall processing capacity. The supercomputers that already are now in existence can really expedite that whole effort. We have recognized it within our world on the seismic side, for instance, where we have the same kind of problem. That is a very large data base, an awful lot of crunching of data, similar to LANDSAT-type data processing. Major improvements over the last 5 years in the whole processing capability have occurred. Although we have been collecting more and more data plus doing more detailed data processing, we have also been improving the hardware and the software commensurate with the increased data-rate and we have actually realized a cheaper cost in the processing of the seismic data. At the same time, we have been going through the same improvements for processing our LANDSAT data and so I would disagree with the argument that the increased data rates and resolution are going to cost four times the amount. Somebody is ignoring the massive improvements that have already occurred and will continue to occur in the computer technology area.

Mr. FLIPPO. Let me see now. NOAA has been designated as the lead agency. NOAA is apparently going to be guided by—they have formed a committee of non-Federal users, I assume to assist them in their judgments. NASA is doing the research and development on the advanced systems and I would assume that there is great coordination between NOAA and NASA and the user community on what those should be. If I understand you correctly, you are saying that the research and development that NASA is doing on the advanced systems beyond D' will not be the equivalent of SPOT in resolution?

Dr. CORMICK. That is my understanding.

Mr. FLIPPO. I see.

Dr. CORMICK. That may be a security issue more than it is anything else.

Mr. FLIPPO. You are further saying that unless the military restrictions are changed that we are wasting our money to pursue an advanced resolution. Is that right?

Dr. CORMICK. That is right. Perhaps I should amplify on that point. Every time that NASA has presented a budget concerning improvements in technology that would be follow-on projects, the OMB immediately says "hold on." We may have that kind of capa-

bility already somewhere and we have not answered the question of whether it is now within the civilian sector or could be reclassified to be released within the civilian sector. That, Mr. Chairman, is from my point of view, a convenient catch-22. The data or technology does not get released and yet it is there to use as an argument against supporting the improvements of the civilian sector-type of technology. So, there is always that hidden giant under the DOD umbrella which suggests that they have got much better technology and they are even into another generation beyond that, but they have not been forced to reclassify the data or the systems or the technology. Will we have access to it and should we be redundantly creating the same thing in the civilian sector with NASA? We sit in the background unaware of whether that question can be resolved or not, but it will have to be.

Mr. FLIPPO. The gentleman from California?

Mr. BROWN. Would the gentleman yield to me?

Mr. FLIPPO. The gentleman is recognized.

Mr. BROWN. Mr. Chairman, this is the first time I have seen testimony stressing as forcefully the issue of the reclassification of military surveillance data. It is no secret, in fact it has been highly published in many articles on a speculative basis if nothing else, that the military has remote sensing data capable of identifying a golf ball on a green; reading licence plates on automobiles; seeing somebody crying in the street, which obviously implies that they have equipment of a resolution under 1 meter shall we say.

I have at least for the last 15 years, been trying to get access to this on an occasional basis by querying witnesses. I have always been told that this is a matter of the topmost classification and we know that it is. I have never been able to understand the reason.

Ed Teller, for example, who I highly respect, suggested years ago that all of that data be unclassified. It conceals data from us that our enemies already know. I would strongly suggest that this subcommittee request a classified briefing of the technology so that we can make a policy decision as to what we want to do in this field.

Mr. FLIPPO. It is an outstanding suggestion. We will certainly follow up on that, Mr. Brown.

Dr. CORMICK. I can tell you that, Mr. Brown, with the previous administration we did deal with Mr. Brehinski and General Rosenberg (NSC) and so on in talking about those issues. It was, in fact, recommended by the National Security Council that the reclassification process be initiated. It was reviewed by the administration, and was approved apparently by the administration, so we began to proceed along that particular tortuous path. Unfortunately, the DOD somehow manages to come up with one particular technique or another that confounds the issue.

We are now into a new administration and, again, George Bush has made it clear that he thinks it is an excellent idea. We have been dealing with Mike Berda and with the National Security Council again. We have identified a group of end users who have "Q" or other types of security classifications that could take a look at the data and make a judgment call on whether that, indeed, would be useful data or whether it would just totally inundate us with no particular benefits derived. And yet, that group has never

been convened and the issue sits somehow completely stalled, I assume again, by the DOD.

Mr. BROWN. Well, as you have indicated, the last administration reviewed this problem. They went into all the details and they finally ended up by changing their policy guidance from an 80-meter resolution down to what it is right now—20 meters. Unquestionably, this is a compromise between those who wanted to release the data and the military who felt, for any number of interconnected reasons, that it should not be released. I am not prepared to make a judgment on the military's arguments because, quite frankly, they have never presented them to me, and if they did I might agree with them. But, at the present, I think it is hampering policy decisions for us not to have access to the full range of the policy information—I am sure Dr. Calio has all that information and is probably laughing at me but nevertheless I feel very strongly about the subject matter and I would like very much to see it procured.

Mr. FLIPPO. Thank you, Mr. Brown. Mr. Lowery?

Mr. LOWERY. Mr. Chairman, let me just say that my colleague from California's suggestion, to have a classified briefing in this area, makes all the sense in the world. There is no reason in these frugal times to spend untold dollars to redevelop a wheel that has already been created. I can amplify a bit: There is a great deal of concern about some of our adversaries and the need for spending in the defense area. I put this question to the Secretary of Defense just yesterday. A picture is worth a thousand words. This country got turned around so rapidly, I think in 1962, as a result of the Cuban missile crisis, because President Kennedy came forth with some rather convincing photographs, and the American people were solidly with the President. It seems right now is the time for some rather convincing evidence that we have from the SR-71 and satellite photographic evidence of what has been going on in the world. They know that we have got it; everybody knows we have got it. I cannot, for the life of me, understand the reasons for the classification. I think that this committee should probably dig into it for the ultimate users as well as convincing the American people of some of the needs that we have in the area of national security as well as defense spending.

Mr. FLIPPO. Mr. Hollenbeck?

Mr. HOLLENBECK. Thank you, Mr. Chairman, I do not have any comments to add except to echo the views of the two gentlemen from California. It is a frustrating and a somewhat ridiculous situation that we are in and I would urge you, Mr. Chairman, to hold those hearings as expeditiously as possible.

I have no questions, Mr. Chairman. Most of those that I had have been adequately answered in the testimony and in the response to the other questions.

Mr. FLIPPO. Dr. Cormick, thank you very much for your testimony. In regard to the last recommendation, No. 13, about more input by the end-user community to this and associated committees, you are always welcome here.

Dr. CORMICK. Thank you, very much.

Mr. FLIPPO. We were pleased to have your testimony.

The committee stands in recess until 2 p.m. this afternoon in this room.

[Whereupon the subcommittee recessed at 11:55 a.m. to reconvene at 2 p.m., to again resume the 1983 NASA Authorization.]

AFTERNOON SESSION

1983 NASA AUTHORIZATION

The subcommittee met, pursuant to recess, at 2:05 p.m., in room 2325, Rayburn House Office Building, Hon. Ronnie G. Flippo (chairman of the subcommittee) presiding.

Present: Representatives Flippo, Hollenbeck, McGrath, and Lowery

Mr. FLIPPO. The hearing will come to order.

This afternoon the Subcommittee on Space Science and Applications will continue its deliberations on the fiscal year 1983 NASA authorization bill by hearing testimony from the Office of Tracking and Data Acquisition, the Office of Aeronautics and Space Technology, and the Office of Technology Utilization.

These offices, while not always in the limelight of the highly visible NASA activities, perform a very vital function. I would like to take this opportunity to congratulate Ed Smylie and the tracking and data team for their outstanding suppport of the two Space shuttle missions that we have had to date.

Before proceeding with these witnesses, however, we will hear from the Honorable Newt Gingrich, who will share with us his views on the fiscal year 1983 NASA authorization. Mr. Gingrich is to be congratulated for his initiatives and leadership in founding the Congressional Space Caucus, of which I am happy to be a part.

Then we will hear from Mr. Smylie, Associate Administrator for Space Tracking and Data Systems, followed by Dr. Jack Kerrebrock, Associate Administrator, Office of Aeronautics and Space Technology, and Mr. Robert Allnutt, Acting Associate Administrator for External Relations.

Mr. Gingrich, would you please come to the witness table and proceed as you deem appropriate?

STATEMENT OF HON. NEWT GINGRICH, A MEMBER OF CONGRESS FROM THE STATE OF GEORGIA

Mr. GINGRICH. I want to thank you for having me here today.

What I want to say may seem a bit outside the ordinary in this day of worrying about the deficit and other concerns, but I would ask you to bear with me for a minute. I would like to make the argument that we should spend every penny that is reasonable on space this year. We should not waste a dime or spend any more than the system can absorb, but we should spend literally every penny that is reasonable.

We should do that becasue space, along with computers and biology, is America's frontier. America grows, survives, and creates jobs by moving into its frontiers. In the past when we converted from the horse and buggy, it was because there was an automobile. When we changed from railroads for passenger transportation, it was becasue there were airlines. When we lost jobs in candlemaking and whale oil manufacturing, it was because there was electricity, and we gained many more jobs in the electrical industry than we ever had in candlemaking or whale oil manufacturing.

Today we are sick economically because for a decade the welfare state has strangled the creation of new jobs. If we had not been so timid in 1969 when our astronauts returned from the Moon and we gave up on the project as a successful and completed stunt, if we had invested every year from 1969 to 1982 the same amount we had in the space exploration budget in 1969, we would today have a NASA budget of $15 billion rather than $6.6 billion.

Unlike the Japanese and German economic efforts, we walked away from the opportunities we could have developed. We were at a point where we could have dominated space for defense, created jobs, and learned a great deal in science; and the world would have understood that America is the leading country because in the most visible arena, we would have led everyone.

To do that, we would have spent in the last 13 years a total of about $150 billion rather than the $60 billion we actually spent. If we had just stayed at the 1969 spending level, today, while I am sitting here, there would be an industrial park in space; there would be a dozen different things going on right this minute; and we would probably have 500,000 additional jobs in America, generating income, exports, and most important, new knowledge and skills. We would dominate the world high-technology market that would lead to another 500,000 new jobs in America.

Those million people are not working today because we did not have the guts to continue the American dream. That's not CETA jobs; that's not temporary employment; it is the creation of a new world.

In 1843, Stephen Douglas had the courage to suggest that we build a transcontinental railroad, and we opened up America, created a steel industry, and built the future. In 1961, John F. Kennedy had the vision to open up a new railroad and 8 years later we betrayed him when we walked away. We claim we are doing all we can. Not only have we not driven the space equivalent of the golden spike in Utah, we aren't even to St. Louis.

Our job in 1982 is to take every dime we can find. When people tell you, "Don't spend on space because of the deficit," it is like telling a corporation not to invest in a new factory because one of the stockholders is a drunken sailor and spends his dividends. There is good spending and there is bad spending; good spending builds the future.

Every conservative who wanted to save the Panama Canal has to start by realizing the Government built the Panama Canal. You can't save what you won't build. Ronald Reagan has the chance to be not only the President who wanted to save the Panama Canal; he can be the President who, like Theodore Roosevelt, wants to build the canal of the future.

It is very clear technically that NASA could spend $9 billion in fiscal 1983. With $9 billion we could do these projects: One, we could build a fifth orbiter for the Shuttle program; two, we could establish a permanent base in Earth orbit; three, we could conduct a much more vigorous program of scientific research that would ultimately lead to the visitation of a carbonaceous asteroid by the end of the decade and the development of the resources of the solar system; and, finally, four, we could maintain an aeronautical research program that would insure this country's position in avi-

ation and thereby protect our best high-technology export industry and the thousands of jobs tied to it.

The relatively small investment in aviation technology is particularly important, not only because it insures our leading position in military aviation, but it also has very important economic consequences as well. The aviation industry is one of the important exceptions to the exporting of jobs that has unfortunately occurred in so many other industries in recent years. America manufactures more airplanes than anyone else in the world only because we have consciously maintained our technological base in aeronautucal research. In effect, research and development have eliminated the need for tariffs and quota.

However, people will come back and say:

> Well, we don't want to spend on this because maybe we can get it out of private industry, and we don't need to be spending on that because, after all, it is only science.

Those people would not have sent Lewis and Clark to the Pacific Ocean like Thomas Jefferson, and how could any good Democrat refuse to follow Jefferson's footsteps? Those people would not have built the transcontinental railroad with Government subsidies, Government land, and Government help. How could anyone from the States that were opened up by those railroads, whose pioneers only got there because of those railroads, turn down this chance. Those people would not have built the Panama Canal. How could any Republican fail to follow Theodore Roosevelt?

Therefore, any NASA budget less that $9 billion betrays the spirit of John F. Kennedy, denies the tradition of Thomas Jefferson, laughs at the courage of Theodore Roosevelt, and means 10 years from now we will have another million Americans who will not be working because we did not have the courage to open up the frontier that is available.

That is why the only practical budget that takes seriously the challenge of creating jobs, defending America, and discovering the knowledge that lets free people grow healthier and richer and wiser, is a budget of $9 billion. That is the only budget we can be proud of.

Let me just say in closing—and I appreciate very, very much, Mr. Flippo, your letting me come today—that if we are going to create a future in which America is both safe and prosperous, and if we are going to come out of this morass of deficits and high unemployment, and I think in many ways despair, this committee will emerge as one of the most important committees of the Congress. It will replace in importance, I think many of the other committees.

I just wanted to come today to encourage you and the other members and to pledge my support for the highest possible authorization that you feel in good conscience you can bring to the floor because I think it is desperately important that we set a beacon of hope for our young people, so that they understand why they should go to school and become engineers, and so they understand what kind of a future is possible for them if we pursue the possibility that I know for many years you have been exploring and you have been supporting.

I thank you.

Mr. FLIPPO. Congressman, your somewhat original thinking and eloquent statements in the Nation's defense area, the Department of Defense, have contributed greatly to the national debate and you are continuing that same record of excellence in the science and applications area of space as well.

This committee has traditionally shared you vision. We agree with many of your views and we certainly look forward to your support and that of the caucus as we go forward.

Mr. GINGRICH. Thank you very much.

Mr. FLIPPO. At this time we would like to receive the testimony of Mr. Smylie and Dr. Kerrebrock. I believe we would like to take Mr. Smylie's testimony first and then the others, in that order.

We are pleasd to have you with us. You might introduce those at the desk with you. Please proceed.

STATEMENT OF ROBERT E. SMYLIE, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE TRACKING AND DATA SYSTEMS, NASA, ACCOMPANIED BY COL. NORMAN POZINSKY, DEPUTY ASSOCIATE ADMINISTRATOR FOR SPACE TRACKING AND DATA SYSTEMS; AND RONALD R. DAPICE, DIRECTOR, PROGRAM CONTROL AND RESOURCES MANAGEMENT

Mr. SMYLIE. Thank you, Mr. Chairman. It is certainly a pleasure to be here to present the fiscal year 1983 budget request of the Office of Space Tracking and Data Systems, and to follow such a ringing endorsement of the goals and objectives of the NASA space program.

I have with me my deputy, Colonel Pozinsky, and my resources manager, Mr. Dapice. Also accompanying my are some members of my staff who I may call on to answer questions as we go through the testimony. With your permission, I will enter my prepared statement for the record and and summarize here this afternoon.

Mr. FLIPPO. Without objection, so ordered.

Mr. SMYLIE. There have been no changes in my organization since I was last here, but we have had several key personnel assignments I would like to note for the subcommittee. Mr. Charles Taylor, Director of our Network Systems Division, has retired. He is still with us for a short time in some special projects, and we will sorely miss him when he moves on to other personal pursuits. We were fortunate enough to obtain the services of Mr. Bill Wood, who has been our representative in Australia for the last 2 years, to return and replace Mr. Taylor. Also, as Manager of our Deep Space Network (DSN) we were fortunate to entice Mr. Charles Force—who was previously chief of the Network Operations Division at the Goddard Space Flight Center, and has most recently spent 2 years in industry—to return to us and take on the position to manage the DSN. To replace Mr. Wood in Australia, Dr. Joseph P. Kerwin, a Skylab 2 astronaut, has accepted an assignment in Australia for 2 years beginning in April. We look forward to his assistance in our program in Australia.

I appreciate your comments about our accomplishments in supporting the Shuttle flights. We are also proud of the performance of the DSN in the support of Voyager 2 at Saturn, and some of the

activities that have happened in the past year concerning the execution of the Tracking and Data Relay Satellite program, as well as the ongoing support for many of our missions. Our program does provide vital tracking, command, telemetry, and data acquisition support to meet the requirements for the Earth-orbital science and applications missions, planetary missions, sounding rockets, research aircraft, and all phases of the Space Shuttle program. This support is provided through two worldwide tracking networks. A golbal communications system links tracking sites, control centers, and data processing facilities providing real-time data processing for mission control orbit and attitude determination, as well as routine processing of telemetry data for applications and scientific missions.

In fiscal year 1983, we are requesting a total of $508.9 million to provide for continuation of these vital functions to meet all of our support requirements for NASA flight projects. Under this budget, support will continue for ongoing missions, along with preparations for the Space Telescope, Galileo, Spacelab, and the Uranus encounter of Voyager 2.

A major effort will also continue to consolidate three of our space tracking and data network ground stations with those of the deep space network under the management of the Jet Propulsion Laboratory in the 1984–85 time period. Also, for the first time, funds are included for the initial increment for payment of the TDRSS services.

In the operations area, we are requesting $338.2 million for flight support operations, which represents the major portion of our fiscal year 1983 request. This amount reflects a continuing evalation of support requirements and program reductions which included closing of the Quito, Ecuador, and Tula Peak, N. Mex., tracking facilities; the closure of the DSN 26-meter antenna subnetwork; and staffing reductions at a number of stations.

The increases in fiscal year 1983 represent some amount for inflation or escalation, and the funding of activities in preparation for the initiation of the Tracking and Data Relay Satellite services in fiscal year 1983.

Our operations tend to be labor-intensive, and inflation, due to personnel compensation, does have an impact on our funding requirements. Also, energy costs have increased over the years in spite of a very active conservation program that has steadily reduced the consumption of energy, but increases up to now have caused our actual costs to go up. There are a number of operational activities associated with the preparation for the Tracking and Data Relay Satellite services in 1983, including ground systems that are crucial to the operation of the total system and such things as the completion of the Network Control Center at Goddard, the software associated with that center, and the staffing buildups to operate the ground systems.

In the area of systems implementation, we are requesting $96 million. These funds are required to sustain the existing ground support facilities through normal maintenance and replacement of systems, and implementation of systems to support a wide variety of new missions and new capabilities to meet the special requirements of individual flight projects. Within the sustaining element,

we are continuing a phased replacement of major computer systems at Goddard, upgrading the communications systems, and conducting a study of future Tracking and Data Relay Satellite system configurations to replace the one now underway some time in the 1990's.

Funding is also requested to continue implementation of new capabilities for upcoming missions such as Space Telescope, Galileo, Spacelab, and the Voyager 2 encounter at Uranus. Under this program, extensive effort is also underway to consolidate and reconfigure three STDN stations with the DSN.

We are requesting $13.4 million for advanced systems. This represents a minimal increase to keep that activity, which I consider to be very important to our future, at essentially a constant purchasing power compared to fiscal year 1982. With rapid changes taking place in the state of the art of telecommunications and computers, these areas need to be continually assessed and technology applied to meet advances required for mission support. Some of these technologies include improved navigation accuracies for planetary spacecraft, use of higher frequencies, and the digital processing of very high telemetry data rates. It is through such efforts that a crucial technology base is developed and made available for future support capabilities.

There is $61.3 million requested for the first payment for the initiation of Tracking and Data Relay Satellite services. These services, as you know, are being procured through a long-term service contract from the Space Communications Co., and the funds are to initiate the repayment of the construction loan and to begin to make operations and award fee payments to the contractor for services provided. Our current estimate for the NASA cost for the 10-year service contract, including development, operations, and interest costs, and the launch costs of the first three satellites, is $2.3 billion based on the initiation of these loan repayments in July of 1983.

I would like to say a few words about the status and the progress concerning the Tracking and Data Relay Satellite. During fiscal year 1983, we plan to launch the first two spacecraft and establish our initial operating capability. The first spacecraft has completed its environmental test program, including thermal vacuum, successfully.

Last year I discussed some technical concerns we had involving primarily the solar arrays and the traveling wave tube amplifiers with you. I am pleased to say that we have both of those areas of technical concern under control. The solar array has been redesigned to relieve thermal stress. Final testing is underway and we believe that the TWTA manufacturing process' changes have resulted in the production of tubes of the reliability necessary for an extended service period. The ground terminal at White Sands is progressing well. We have substituted upgraded computers in the ground station. The software debugging and service level testing is continuing. We have initiated data flow and compatibility testing between the NASA systems and the contactor ground terminal, and we will complete the baseline software and hardware testing this spring.

There are several other NASA systems that are vital to the total integration and use of the tracking and data relay satellite system. These are primarily the NASA ground terminal colocated with the contractor terminal at White Sands, the Network Control Center at Goddard, and the associated computing and interconnecting communications systems. These systems are all in various stages of delivery, installation, and test, and are for the most part progressing well.

The Network Control Center at Goddard, I believe I reported last year was having some difficulty in development of the software and the schedule for the availability of that software was of some concern. We have reevaluated that over the past year and have a modified hardware/software approach that provides an initial operating capability that is now being implemented and on schedule. This system will be upgraded as the numbers and types of tracking and data relay satellite users increase. In addition, we have initiated a simplified backup capability as an alternate interface to the White Sands station in case of unforeseen problems with the primary activity.

There will be increased activity this year in the area of launch preparation and mission planning, since our first launch is now scheduled for January of next year. As you know, this will be the first launch of the inertial upper stage from the Shuttle and we will also be dealing with the first launch of Orbiter .099 and the first TDRSS spacecraft, making the event a complex and challenging mission. It requires a great deal of coordination and detailed planning, since the Shuttle will be controlled from the Johnson Space Center, the IUS from the satellite control facility at Sunnyvale, and the tracking and data relay satellite from White Sands. We have established intense planning activities involving all of the organizations that will conduct that launch and initial operating capability, and we believe that we have things well underway toward a successful launch of that first satellite early next year.

I believe that I will stop there with my prepared comments and be prepared to answer questions at this time.

[The prepared statement, plus answers to questions asked of Mr. Smylie follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS

STATEMENT OF
R. E. SMYLIE
ASSOCIATE ADMINISTRATOR FOR
SPACE TRACKING AND DATA SYSTEMS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

Mr. Chairman and Members of the Subcommittee:

It is again a pleasure to appear before this Subcommittee to present the FY 1983 budget request for the NASA Space Tracking and Data Systems Program. I shall also review significant activities since my testimony last Spring and discuss our current and planned activities for providing support services to all NASA flight projects.

As you know, the Space Tracking and Data Systems Program provides vital tracking, command, telemetry, and data acquisition support to meet the requirements for Earth-orbital science and applications missions, planetary missions, sounding rockets, research aircraft, and all phases of the Space Shuttle Program. Two worldwide tracking networks, one for deep space missions and one for Earth-orbital missions, provide this support. A global communications system links tracking sites, control centers, and data processing facilities providing real-time data processing for mission control, orbit and attitude determination, as well as routine processing of telemetry data for applications and scientific missions.

FY 1983 BUDGET REQUEST

For FY 1983, we are requesting a total of $508.9 million to provide for continuation of our vital tracking, command, telemetry, and data acquisition support to meet all of our support requirements for NASA flight projects. In FY 1983, support will continue for ongoing missions along with preparations for Space Telescope, Galileo, Spacelab, and the Uranus Encounter of Voyager 2. A major effort will continue also to consolidate three Spaceflight Tracking and Data Network (STDN) stations with those of the Deep Space Network (DSN) under the management of the Jet Propulsion Laboratory (JPL) in the 1984/1985 time period.

In addition, the FY 1983 budget request includes funds for the initial increment for Tracking and Data Relay Satellite System (TDRSS) services.

OPERATIONS

Program funding of $338.2 million is required for flight support

operations and represents the major portion of our total FY 1983 request. The requested amount represents constrained funding and program reductions taken in both FY 1982 and FY 1983, and a continuing evaluation of support requirements. Among the program reductions were the closure of the Quito, Ecuador, and Tula Peak, New Mexico, tracking facilities, the closure of the DSN 26-meter antenna subnetwork, and staffing reductions at a number of tracking stations.

The only significant increases provided for in the FY 1983 request are for a minimal amount of escalation and the funding of activities in preparation for the initiation of TDRSS services in FY 1983. Since our operations are labor intensive, inflation due to personnel compensation has a significant impact on our funding requirements. Also, our tracking station energy cost continues to increase in spite of decreases in consumption through conservation and station closures. In preparing for the initiation of TDRSS service in FY 1983, there are a number of operational activities associated with the TDRSS related ground systems that are crucial to the operation of the total system such as completion of the Network Control Center (NCC) software and the staffing buildups to operate the ground systems.

SYSTEMS IMPLEMENTATION

For Systems Implementation, we are requesting $96.0 million. Funding is required to sustain the existing ground support facilities and systems to support a wide variety of space missions and to provide new capabilities to meet the special requirements of individual flight projects.

Within the sustaining element of the Systems Implementation program, we are continuing a phased replacement of major computer systems at the Goddard Space Flight Center (GSFC), upgrading the communications system at GSFC, conducting a study of future Tracking and Data Relay Satellite System (TDRSS) configurations, and undertaking the development of on-board systems to work with TDRSS.

Systems Implementation funding is required to continue implementation of new capabilities for upcoming missions, including Space Telescope, Galileo, Spacelab and Uranus Encounter of Voyager 2. In addition to the above missions, an extensive effort is underway to consolidate and reconfigure STDN stations with the DSN. The reconfiguration will include the implementation of centralized signal processing facilities at each DSN complex along with an antenna arraying capability. Automation will be designed into these major capabilities in order to maximize the savings in the maintenance and operation of the consolidated network.

ADVANCED SYSTEMS

We are requesting $13.4 million for this vital element in the Office of Space Tracking and Data Systems (OSTDS) program. With the rapid changes taking place in the state of the art in telecommunications and computer technology, there is a continuing need in these areas of technology to assess and apply these advances to mission support. Areas in which such technology can be applied to future mission support include improved navigation accuracies for planetary spacecraft, use of higher frequencies such as K-Band and the digital processing of very high telemetry data rates. It is through such

efforts that a crucial technology base is developed and made available for future support capabilities.

TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS)

$61.3 million is included in our FY 1983 request for the payment for the initiation of TDRSS service. TDRSS services are being procured through a long term contract from Space Communications Company (SCC). Funds requested for FY 1983 are to initiate repayment of the construction loan and to make operations and award fee payments to SCC for the services provided. Our current estimate of the NASA cost for the ten year service contract, including development, operations, and interest costs, is $2.3 billion based on the initiation of loan repayments in July 1983.

NETWORK SYSTEMS

SPACEFLIGHT TRACKING AND DATA NETWORK (STDN)

All launch and orbit phase support of Earth orbital missions, including the Space Shuttle, are supported by the STDN. Presently, there are 11 general purpose stations in the network, two Shuttle special purpose telemetry, voice and command stations, and three air-to-ground UHF Shuttle voice stations. In addition, the Office of Space Tracking and Data Systems has the responsibility for the operation and maintenance of ten laser ranging stations in support of the NASA Geodynamics Program. From these networks, housekeeping applications and scientific data are acquired, processed, and transferred to project control centers and on to experimenters.

Since this time last year, we have reduced our network capability by closing the general purpose station at Quito, Ecuador, and the special purpose station at Tula Peak, New Mexico. In addition to these closures, we reduced personnel at the Alaska, Hawaii, and Merritt Island stations. We anticipate closing the Buckhorn, California, special purpose station when Shuttle landings are targeted to the Kennedy Space Center (KSC) later this year. In addition, our FY 1983 budget calls for staffing reductions at Guam, Ascension Island, and Santiago beginning in October 1982.

The projected workload in FY 1983 which the STDN will support is a bit higher than in FY 1982. We provide both launch and on-orbit support to missions of foreign countries and commercial firms on a reimbursable, non-interference basis. With the reduced support capability, the network will be stressed in meeting the heavy workload.

SHUTTLE SUPPORT

Since my testimony last Spring, the STDN concluded preparations and testing and twice achieved a peak readiness to support the two Space Shuttle missions last April and November. The NASA STDN was supplemented by the United States Air Force site in the Indian Ocean. To insure complete data gathering during the critical launch and landing phases, three Shuttle unique telemetry, command and voice stations were established at Ponce-de-Leon, Florida; Buckhorn, California; and Tula Peak, New Mexico. Special Shuttle air-to-ground voice communications stations were colocated at Intelsat ground stations

in Senegal and Botswana, as well as at our laser tracking site at Yarragadee, Australia, and the USAF Indian Ocean station. These latter stations filled in gaps in voice coverage. After STS-2, it was decided that as an economy move, coverage from Quito, Ecuador, could be eliminated and the operations at that station terminated with the last Shuttle pass on November 14, 1981. Likewise, the special purpose station at Tula Peak, New Mexico, was closed the same day due to changing programmatic requirements.

Revalidation and verification of equipment and procedures are currently being performed to achieve readiness to support the STS-3 mission in March.

An agreement was reached with the Government of Senegal which will allow upgrade of the present Dakar air-to-ground voice station to an S-Band telemetry, voice and command station before the STS-4 mission in mid-1982. Efforts are well underway to refurbish and repackage the Tula Peak equipment and establish communications circuits by early June to meet this requirement. Without this change at Dakar, there would be a gap in data coverage between Bermuda and Hawaii for all due East launches which begin with STS-4. This mid-point station will allow analysis of initial orbital maneuvering system burn data and provide for crew updates in the event of any trans-atlantic abort or abort-once-around cases. Crew safety will be enhanced by this added capability in Dakar.

DEEP SPACE NETWORK (DSN)

During the past year, the DSN supported 11 spacecraft in interplanetary travel which included the seven Pioneers, Helios 1, the remaining Viking Lander, and the two Voyagers. The paramount support activity was the very successful Voyager 2 encounter of the Saturnian system which resulted in return of 11,820 images of Saturn and its environment. As was the case during the Voyager 1 encounter with Saturn, the use of antenna arraying greatly enhanced the performance of the deep space stations to receive the signals which traveled over one and a half billion kilometers to Earth. Following its rendezvous with Saturn, Voyager 2 has been placed on a trajectory for Uranus, where it is scheduled to arrive in early 1986.

In addition to the exciting encounter of the Saturnian system, the network supported a number of less publicized, but still notable scientific activities. These included superior conjuctions with the Pioneer 10, 11, and the Voyager 2 spacecraft during which the Sun came directly between the respective spacecraft and the Earth. During the superior conjunctions minor variations in the radiometric data are measured, which allow the scientist to estimate the solar wind velocity and the electron content between the spacecraft and Earth. The network also supported the Helios 1 fourteenth solar perihelion period (near approach to the Sun) activity. During the perihelion, the Faraday Rotation Coefficients are measured from which the variations in the Sun's magnetic field can be derived. All of these events were supported with minimal problems by the network.

Another major factor in the FY 1983 submission was the closure of the 26-meter antenna stations in December 1981. This action was taken to reduce FY 1983 costs. A reevaluation of flight project requirements after the Voyager 2 encounter of Saturn confirmed that

the 26-meter stations could be closed with the DSN still providing adequate support from the remaining 34- and 64-meter antenna stations.

COMMUNICATIONS

The NASCOM Network is a generic term referring collectively to the circuits, switching and terminal facilities arranged in a global system established and operated by NASA to provide long haul operational communications support for all NASA projects. NASCOM interconnects such facilities as NASA's foreign and domestic tracking and telemetry acquisition sites; launch areas; mission and network control centers.

NASCOM uses, in most instances, full period circuits or services obtained through lease from 16 domestic and 10 foreign carriers, using a variety of their communications satellite, terrestrial cable, microwave relay, and submarine cable facilities. The overall management of NASCOM is centered at the Goddard Space Flight Center (GSFC).

The Communications support of the Space Shuttle (STS-1 and STS-2) missions was highly successful. Installation, test, and verification continues on the performance of the 50 megabit wideband data handling equipment for the Tracking and Data Relay Satellite System (TDRSS). This system between GSFC, Johnson Space Center (JSC) and the facility at White Sands, New Mexico, will be used to support all low orbiting spacecraft when the TDRSS becomes operational.

During the first quarter of FY 1983, a 50 megabit circuit will be activated from the White Sands ground terminal to JSC and GSFC. This capability will be used to meet the high data rate requirements for Spacelab and Landsat-D.

Work will be initiated to conduct operational tests of a multiple access mode of operation using existing domestic satellite transponders. This mode will provide a greater transfer of data over the same transponder capacity. This will increase the effective use of the transponder capacity without increasing the cost to the user. Work also is continuing at GSFC for relaying high rate computer-to-computer data transfer via fiber optic distribution systems.

CONTROL CENTERS

Currently, we operate five control centers for the monitoring, command, and control of some 20 spacecraft. In addition, a new control center is being implemented for the Space Telescope. Funds are requested in FY 1983 to continue the development and installation of the Space Telescope Control Center hardware and systems software. Also in FY 1983, funds are requested to continue the software activity necessary to support the high precision target pointing, command management, mission scheduling, attitude control and operation of the several instruments on-board the Space Telescope. Initial control center testing with the flight experiments hardware will also take place in FY 1983 in preparation for the FY 1985 launch.

Upgrading of the Multisatellite Operations Control Center (MSOCC), a single facility which is controlling 10 existing spacecraft, will continue. This control center will also be the operating facility for future new spacecraft such as Earth Radiation Budget Satellite

(ERBS). MSOCC utilizes pooled facilities from which selected equipment and computers are electronically connected to support each spacecraft pass. After the pass, the selected equipment is released and becomes available for other spacecraft passes. By using the same equipment to sequentially support different spacecraft, the upgraded MSOCC will be capable of supporting 15 to 20 spacecraft depending upon the monitoring and control requirements of each spacecraft. The majority of the hardware has been purchased. In FY 1983, it is planned to procure the necessary interface equipment to network the major MSOCC computers for the exchange of data and programs and to procure a processor for software development and post pass spacecraft verification and analysis.

SUPPORT COMPUTING ACTIVITIES

Activities in this category are directed toward providing near-real-time support to spacecraft operations such as orbit determination, attitude determination, maneuver computation and command management, and indirect support for such vital functions as scheduling and modeling. The large computer complex which provides this support is about 16 years old. Increasing failure rates affect its operational capability and reliability thereby jeopardizing mission success. Extra expenditures to ensure mission success have been initiated to bring in vendor engineers to be continuously available during critical support to STS and expendable launch vehicles. This procedure will remain in effect until the replacement systems become operational.

A sequential replacement of several computer systems has been undertaken. In FY 1979, funds were made available to replace the Metric Data Facility (MDF) which is currently undergoing acceptance testing and will become operational in March 1982. Because of unacceptable vendor response to the RFP for the Flight Dynamics System (FDS), a delay was necessary to restructure the acquisition strategy. An RFP based on lease with option to buy will be released early in 1982 with a planned operational date in mid 1983. The third computer system to be replaced, the Command Management System (CMS), was deferred from FY 1981 to FY 1982 at the time the amended FY 1981 budget was submitted. Funds for this system have been programmed in FY 1982, but at a reduced level in the amended FY 1982 budget. This reduction necessitated a change in acquisition strategy from purchase to lease with option to purchase. The fourth computer system to be replaced is the Orbit Computation System (OCS), and acquisition will be initiated in FY 1983.

The Operations and Maintenance (O&M) of this large computer complex will be conducted under a contract awarded in FY 1982 for a period of five years. In addition, the associated programming, computation, and analysis activities will continue under a new contract to be negotiated in FY 1983.

DATA PROCESSING

Another very important support function provided by OSTDS is the processing of bulk science data from various spacecraft. Traditionally, the receipt, capture, accounting, and product generation activities have been classified broadly into two major categories, image and telemetry (non-image) data processing. The Image Processing Facility (IPF) converts the data from measurements made by the spacecraft of

Earth features or phenomena into pictures or their digital representation on computer tapes. In telemetry data processing, the science data is separated for the individual investigators and recorded on experimenter tapes. Also plots or histograms may be produced. A major subset of the telemetry data processing activities in the future will be the processing of data from Spacelab missions by the Spacelab Data Processing Facility (SLDPF) which is currently under development.

As indicated previously, the IPF was designed to process data from Earth sensing application missions. Currently, the facility processes data from Landsats 2 and 3, Heat Capacity Mapping Mission (HCMM), and Nimbus spacecraft. The facility is meeting and, in some cases, exceeding production levels required by the users because of improvements made to the facility production systems in FY 1981. FY 1983 funds will be utilized to continue the operation to process the large number of retrospective orders being received from the Department of Interior.

The Telemetry On-Line Processing System (TELOPS) serves as the input processor for telemetry data. Its associated output processor, the Univac 1100/82 computer, will also provide the output processor function for the Spacelab Data Processing Facility which will be discussed later. In FY 1983, tape and disc units will be added to this computer to improve its reliability and efficiency in the dual output processor role.

Currently, telemetry data is time division multiplexed with the concept of generating packetized telemetry data, instead, for reduced ground data processing complexity and shorter delivery time to the user or experimenter. The purpose of the packetized telemetry is to provide the required ancillary data with the bulk science data at the data source and avoid the merging of these data in the ground data processing system. The Space Telescope will be the first mission to use some of the concepts of packetized telemetry. FY 1983 funds are required for the continued development of a data capture facility to receive, error check, and forward data to the Space Telescope Science Institute.

Also, funds are required in FY 1983 to continue the development of the Spacelab Data Processing Facility (SLDPF). The Spacelab missions will generate very complex data streams consisting of analog, audio, instrumentation, and variable rate digital data. An all new input processor (hardware and software) is required to capture, quality check, account for, preprocess, and generate output products for the European Space Agency (ESA) and U. S. investigators. The data capture capability for SLDPF is greater in magnitude than that required initially in the TELOPS design for free flyer spacecraft.

TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS)

The TDRSS, as you know, will consist of an operational constellation of four spacecraft in geosynchronous orbit, a ground terminal located at White Sands, New Mexico, and scheduling and communication facilities at the GSFC. Of the four spacecraft, two will be dedicated to NASA service; one will provide commercial service; and the fourth will serve as a shared spare to maintain both services.

During FY 1983, we plan to conduct two launches and establish the initial operating capability.

This satellite constellation will provide ten years of satellite service to NASA under the terms of the contract with Space Communications Company (SCC), a partnership of subsidiaries of Western Union, Continental Telephone, and Fairchild Industries. During the development phase, TRW and Harris Corporation are major subcontractors to SCC for the space and ground segments respectively with TRW also responsible for overall systems integration.

Since my last appearance, a number of significant program milestones have been accomplished. The first spacecraft has completed its environmental test program. Vibration, acoustic, and pyroshock tests were completed, demonstrating successfully the ability of the spacecraft to withstand the extremes of the launch environment, spacecraft separation, and appendage deployment. In addition, a lengthy thermal vacuum test of more than 50 days was completed, providing design verification for the spacecraft, antenna, payload modules and the large, single access antenna compartments.

While some minor problems did occur during the thermal vacuum test, no major design problems were encountered, and the spacecraft performed admirably.

At this time last year, I shared with you some technical concerns involving the solar arrays and the Travelling Wave Tube Amplifiers (TWTA's). Both of these major elements now are performing well. The solar array design has been modified to relieve thermal stress and final testing of the revised design is underway. The TWTA manufacturing processes have been altered, resulting in the production of better quality tubes with the high reliability necessary for an extended service period.

In 1979, NASA and the DOD jointly studied the security issue associated with the TDRSS operation. In 1980, the TDRSS contractor initiated Phase A of an implementation to install National Security Agency (NSA) provided equipment into the TDRSS spacecraft. In June 1981, the United States Air Force (USAF) recommended termination of this effort due to technical cost and schedule concerns.

NASA, NSA, and our contractors then proceeded with the study of an alternate approach which is now being implemented. This approach involves the installation of currently available hardware. We are also in the process of modifying the ground station to increase the transmitted power to the spacecraft. This combination greatly enhances the operational utility of TDRSS to all users.

To meet DOD security requirements associated with the TDRSS scheduling and control, facilities at GSFC and the required communications links are being secured. This effort is being implemented by NASA and is funded by the DOD.

The TDRSS ground terminal is progressing well. At this time last year, consideration was being given to substituting more capable computers in the ground terminal to forestall operational problems and incorporate security changes. Last summer, that substitution was made and the new data processing equipment has been installed

and integrated. Software debugging and service level testing for the ground terminal are continuing. Initial data flow and compatibility testing between NASA systems and the ground terminal have been initiated. Testing for the baseline software and hardware will be completed this Spring when testing of security modifications to hardware and software will be initiated. Verification and failover testing will be completed by September, and systems and interface testing for launch and flight operations will be initiated in October.

Several NASA systems are integral to the delivery of user support services via TDRSS. Key elements are: the NASA Ground Terminal (NGT), the Network Control Center (NCC), and the associated computing and interconnecting communications systems. These systems are in various stages of delivery, installation, and test and are, for the most part, progressing well.

At the NGT, colocated with the TDRSS ground terminal at White Sands, New Mexico, the fault isolation and monitoring system software and hardware testing is underway. This system will monitor TDRSS service performance and provide the capability to isolate service failures and rapidly restore user services when failures occur. It is scheduled to complete its testing this April.

The NCC controls the scheduling of the TDRSS services. Some difficulty has been experienced in the readiness of this facility primarily in software availability. This system has been reexamined over the past year and a modified hardware/software approach that provides an initial operating capability is now being implemented. This system will be upgraded as the numbers and types of TDRSS users increase. In addition, a simplified backup capability is being provided as an alternate interface to the White Sands station.

There will be increased activity this year in the area of launch preparation and mission planning for the TDRSS. As you know, TDRSS will be the first launch of the Inertial Upper Stage (IUS) from the Shuttle. Our mission preparation and planning will be dealing with the first launch of Orbiter 099, the first IUS, and the first TDRSS spacecraft, making it an extremely complex mission. It requires a great deal of coordination and detailed planning since the Shuttle will be controlled from the Johnson Space Center (JSC), the IUS from the U. S. Air Force control center at Sunnyvale, California, and the TDRSS from White Sands.

STATION CLOSURE AND NETWORK CONSOLIDATION

As a continuing effort to achieve economies, we terminated our use of the Winkfield, England, station in October 1980; ceased operation at Rosman, North Carolina, in January 1981; deleted links in Alaska and Greenbelt, Maryland, in 1980; and closed the stations at Quito, Ecuador, and Tula Peak, New Mexico, in November 1981 and reduced staffing at several stations. We anticipate closing the station at Buckhorn, California, when Shuttle landings are targeted to KSC later this year. The closure of these links represents a reduction of about 31 percent in network telemetry, tracking, and command capability. Correspondingly, acquisition time has decreased 40 percent while the number of on-orbit spacecraft has decreased about 18 percent since 1978.

When the TDRSS achieves operational capability in 1984, Earth orbit spacecraft will be supported by this system. This will permit closure of the STDN network stations located in Guam; Hawaii; Santiago, Chile; and Ascension Island. Operations at the special purpose Shuttle stations at Dakar, Senegal; Gaborone, Botswana, and Yarragadee, Australia, will be terminated.

The Alaska station will support Landsat and Nimbus satellites through October 1984, when responsibility for that station will be transferred to National Oceanic and Atmospheric Administration (NOAA). The three STDN stations in California, Spain, and Australia will continue to support highly elliptical and geosynchronous spacecraft which are beyond the TDRSS view from synchronous orbit, as well as provide backup support for Shuttle and TDRSS in emergency situations. The Greenbelt, Maryland, tracking station will be retained until support for the International Ultraviolet Explorer (IUE) is ended. The Bermuda and Merrit Island tracking stations will be partially deactivated in 1984, and will support only launch and landing tasks.

As mentioned earlier, we are continuing with our activities to consolidate the three remaining STDN stations in California, Spain, and Australia with the DSN stations at these locations under the single management of the Jet Propulsion Laboratory (JPL). A new 34-meter antenna will be added to the DSN complex at Goldstone, California, and also at the DSN complex at Canberra, Australia. Later, one antenna from each of the STDN stations in Australia, Spain, and California, will be relocated and integrated into the DSN complexes. These relocated antennas will be used for Earth orbiting spacecraft that cannot be supported by TDRSS. Each station complex will have a shared signal processing facility that will provide centralized monitor and control capability for all the antennas, including all of the digital electronics required for uplink command encoding and downlink demodulation and recording. This shared facility plus centralized maintenance and support services at each complex will provide a great economy of operation.

At the completion of the consolidation activities in 1985, each of the DSN complexes will have the capability to support combinations of deep space probes or Earth orbiting spacecraft outside the viewing constraints of TDRSS. The 64-meter and 34-meter antennas at each site will have a capability to be arrayed in order to effectively increase the aperture available.

AERONAUTICS AND SOUNDING ROCKETS

The Space Tracking and Data Systems Program provides tracking, data acquisition, communications, command and control, and data processing support for aeronautical research and scientific sounding rocket and balloon activities conducted under the direction of GSFC at the Wallops Flight Center (WFC) in Virginia, and the Dryden Flight Research Facility (DFRF) in California, which is under the direction of the Ames Research Center. In addition to supporting these research and science activities with fixed facilities, we maintain a capability at WFC to provide tracking and data acquisition support at remote locations using mobile instrumentation. At WFC, impact prediction and range surveillance activities are supported as a part of the range safety functions.

Plans for FY 1983 include the continuation of the tracking and data

support of the aeronautics, sounding rocket, and balloon activities conducted by the WFC and the continuation of a phased program of equipment modernization.

The activities supported at DFRF are related to aeronautical flight research in all flight regimes, with emphasis on high performance flight research, including use of Remotely Piloted Research Vehicles (RPRV). We also provide for the acquisition, processing, display, and distribution of mission test information through the use of telemetry, communications and space positioning systems which comprise the principal aeronautical test range facilities at DFRF.

Flight research activities for FY 1983 and beyond at DFRF are expected to increase and plans are being implemented which provide for upgrades of equipment to keep pace with new requirements. Basic improvements in FY 1983 will continue to be directed at enhancement of telemetry data processing capability along with limited improvements in the long-range optics capability and processing and display of tracking information.

Space Shuttle operations are also supported by the OSTDS facilities at WFC and DFRF which have been configured to meet these requirements. At WFC, the radar and command systems will provide support for the launch phase of the Shuttle missions and DFRF will serve as a secondary landing site for the Shuttle.

ADVANCED SYSTEMS

Our Advanced Systems Program is a relatively small, but vital portion of our program. It provides for technology assessment and application of new technology to future support capabilities that are cost-effective and reliable. It recognizes the tremendous advances taking place in the state of the art in telecommunications and computational technology and the growing need to assess and apply them to mission support. The request for $13.4M for this effort allows for a minimal increase due to inflation. The work is accomplished at the Goddard Space Flight Center for Earth satellite missions and data systems and at the Jet Propulsion Laboratory (JPL) for the deep space missions.

Work includes, for example, extremely precise tracking technology for determining mission angular direction and for measuring time with an accuracy sufficient to track and guide future planetary missions and, as a spin-off, make possible new ground based science experiments, such as, search for gravity waves. Also being pursued is effort aimed at the use of Very Long Baseline Interferometry (VLBI) measurements for the Galileo mission in 1985. Work will continue on development of telecommunications technology, exploring new areas of the frequency spectrum to reduce interference and improve performance. These efforts will improve efficiency, increase the amounts and types of data that can be obtained from deep space missions and correspondingly increase the potential science value of all future investment in planetary missions.

Similarly, for possible future Earth orbital missions during the TDRSS era, data acquisition and processing capability would need to be improved to meet potential requirements of up to 300 million bits per second. The main drivers would be the demands of high resolution sensors such as multispectral scanners, multilinear imaging arrays, and synthetic aperture radars.

New systems and techniques are being pursued to address the transfer of such large volumes of data. These include computer assisted operations, digital processing of high volume data, improved man-machine interfaces and wide band satellite communications to distribute data to processing centers and users. Optical disc storage and automated quality control of data will be investigated to facilitate handling image data processing requirements anticipated for future Earth observation missions.

CONCLUSION

In summary, our mission support capability has been reduced in both the STDN and DSN. Nevertheless, we have successfully supported flight program requirements as exemplified by the excellent support to the Voyager 2 Encounter and the first two Space Shuttle missions. I would like to emphasize, however, that the networks will be strained to their limits in FY 1983 to meet the mission support workload requirements.

The key elements reflected in our FY 1983 budget request of $508.9 million are to provide continuing support to ongoing tracking, command, and data requirements of Earth-Orbital, planetary, and Space Shuttle missions, as well as to the implementation of the networks consolidation program. Preparations and mission planning are underway with two TDRSS launches planned from the Space Shuttle in FY 1983, leading to a full operational capability in 1984.

I urge the full support of this subcommittee for this constrained FY 1983 funding request to meet these essential and vital support requirements.

Mr. Chairman and members of the subcommittee, this concludes my statement. Thank you for this opportunity to present NASA's Space Tracking and Data Systems Program. We are now prepared to respond to your questions.

Thank you.

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE HEARING BEFORE THE HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS ON MARCH 3, 1982, TO MR. SMYLIE.

QUESTION T-1:

The Office of Tracking and Data Acquisition's budget has increased some $100 million over the FY 1982 request.

(a) Could you delineate the reasons for the increase?

(b) Do you anticipate another $100 million increase in next years budget?

ANSWER T-1:

The increase of approximately $100 million in our budget request over the FY 1982 request is principally due to the following:

(a) $60 million in FY 1983 funding is required to initiate repayment of the construction period loan to the Federal Finance Bank (FFB) and for initiation of operations support by the Tracking and Data Relay Satellite System (TDRSS) prime contractor.

$30 million of the increase represents allowance for inflation.

$10 million is required for additional development of TDRSS Network Control Center (NCC) software, project and network support.

(b) The projected payment in FY 1984 of approximately $230 million to the FFB for TDRSS loan repayment will require an increase in the Tracking and Data Acquisition budget in FY 1984 in excess of $100 million.

QUESTION T-2:

Will the closing of the stations that you mentioned in your statement result in any savings of operating funds or are they offset by increased costs?

ANSWER T-2:

In order to continue network operations within the constrained funding availability for FY 1982 and FY 1983, it was necessary to reduce staffing throughout the Space Tracking and Data Network (STDN) and Deep Space Network (DSN). The most significant of these reductions was closure of the STDN station at Quito, Ecuador, and closure of the DSN 26-meter subnet at Goldstone, California; Madrid, Spain; and Canberra, Australia. These closures were effected in order to realize savings during FY 1983. Station operating costs in FY 1983 are approximately $6.9 million below FY 1982 levels before adjustment

for FY 1983 inflation. After adjustment for inflation, the cost decrease is approximately $1.3 million.

QUESTION T-3:

In your statement, you talk about a phased replacement of major computer systems at Goddard.

(a) How long has this process been going on?

(b) When do you anticipate its completion?

(c) Have you considered leasing versus buying the computers?

ANSWER T-3:

(a) A phased computer replacement program was initiated by OSTDS in FY 1979. In that year, the Metric Data Facility (MDF) was put under contract. Development and implementation of this system has proceeded smoothly and the activity will be completed in early 1982. The Flight Dynamics System (FDS), planned for purchase in FY 1980, was delayed due to budget limitations and procurement difficulties. Currently, the FDS is planned as a lease for operation in early 1983.

In FY 1981, replacement activities for three computer systems were initiated: the Command Management and the Data Processing Systems at GSFC and the Impact Prediction System at the Wallops Flight Center. The Command Management System (CMS) was delayed due to FY 1981 budget constraints. Procurement strategy was changed from purchase to lease, with this system scheduled to be operational in 1983. The Data Processing System replacement is being purchased with FY 1981 and FY 1982 funds. The Impact Prediction System main frame is being leased and the peripherals being purchased with FY 1982 funds.

Replacement of the Orbit Computation System (OCS) was similarly delayed due to budget limitations in FY 1982, and will be purchased in FY 1983.

(b) Delivery of all systems will be completed during 1984. In those instances where the systems continue to be leased, however, funding will be required beyond that time.

(c) Lease versus purchase studies are performed on all replacement systems. Generally, it is to the Government's advantage to purchase these systems if the predicted use of the systems exceeds a period ranging from 18 to 30 months. Because of budget limitations, however, it has not been possible to purchase all of the replacement systems. Those

systems planned for lease will include options to purchase in later years.

QUESTION T-4 (a):

Since your operations are so labor intensive, do you have the bulk of your tracking station personnel on long term union agreements?

ANSWER T-4 (a):

Yes. Either union agreements with the companies that operate the stations under contract to NASA or to the foreign government that has an agreement with NASA.

QUESTION T-4 (b):

When are the bulk of the contracts up for renewal?

ANSWER T-4 (b):

Most of the union agreements expire during 1982 and 1983.

QUESTION T-4 (c):

Do you negotiate escalation clauses?

ANSWER T-4 (c):

Union agreements for stations operated by U. S. contractors do not contain an automatic cost of living allowance. Increases in compensation to their employees are generally negotiated to occur in steps during the term of the contract.

For stations operated through arrangements with foreign governments, there are, in most cases, provisions in Labor contracts or laws governing wages, which equate to an automatic cost of living allowance.

QUESTION T-5:

Could you elaborate on your statement that the tracking station energy costs continue to increase in spite of decreases in consumption and conservation?

ANSWER T-5:

The stations primarily consume fuel oil for heating and electrical power generation, as well as commercial electrical power. Such factors as uncertainties in availability of fuel sources, future pricing policies, the state of the international monetary situation, and difficulties in projecting further cost effective economy measures make it extremely difficult to predict future energy costs.

In 1973, an energy conservation program was established at our tracking stations. Since that time, we have succeeded in reducing consumption significantly. However, dramatic cost increases have overshadowed the effect of reduced consumption. In fact, the trend from FY 1973 to FY 1981 clearly reflects cost increases of over 300% inspite of more than 50% reduced consumption. Expressed another way, the unit cost per unit of electricity has increased over five fold. While we do not anticipate a continuation of this startling rate of increase, our experience so far during FY 1982 does not convince us to anticipate a reversal of the general trend.

ANSWER T-6 (a):

Could you discuss your preparation plans for the initiation of TDRSS service?

ANSWER T-6 (a):

There are a number of operational activities associated with the preparation for the initiation of TDRSS service in FY 1983. At the contractor operated TDRSS Ground Terminal at White Sands, New Mexico, software debugging and service level testing are continuing. Initial data flow and compatibility testing between NASA systems and the Ground Terminal have been initiated. Testing for the baseline software and hardware will be completed this Spring. Verification and failover testing will be completed by September, and interface testing for launch and flight operations will be initiated in October.

The NASA Ground Terminal (NGT), colocated with the TDRSS Ground Terminal at White Sands, is testing the fault isolation and monitoring system software and hardware, and is progressing well with completion anticipated this April. The NCC has been modified in both hardware and software in order to upgrade its capability and to provide support for early users. A simplified backup capability is also being implemented in the event the NCC is not prepared to support these activities.

QUESTION T-6 (b):

How much money and personnel resources are committed to this effort?

ANSWER T-6 (b):

For FY 1983, there is about $46 million in operations for the NASA systems which are necessary to provide service to users. These include the NGT, the NCC, the Operations Support Computing Facility, and various other systems necessary to integrate, test, and prepare for TDRSS service. Approximately 800 support contractor personnel are involved in these activities.

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QUESTION T-6 (c):

Do you anticipate a sustaining engineering effort for TDRSS at Goddard?

ANSWER T-6 (c):

A sustaining engineering effort will be required in order to provide the maintenance and engineering services, and replacement parts to support the TDRSS operational system. It is anticipated that this effort will average from $4 million to $6 million each year.

QUESTION T-7 (a):

What does the $61 million in the TDRSS budget request represent?

ANSWER T-7 (a):

The budget request consists of three parts. The largest and most significant is the estimated requirement to initiate FFB loan repayments at $58.9 million. The request also contains the initial operations payment to our service contractor, $.9 million. The last part is $1.5 million to provide support to our project management staff.

QUESTION T-7 (b):

What are the anticipated yearly appropriation requests for TDRSS?

ANSWER T-7 (b):

The currently estimated yearly requests are as follows:

	FY 83	FY 84	FY 85	FY 86	FY 87
($ in Millions)	61.3	229.8	233.0	232.8	232.4

QUESTION T-7 (c):

Are there any plans to change the present contract structure with Spacecom, Inc.?

ANSWER T-7 (c):

A major contract reformation is currently under joint consideration by NASA and Spacecom. The principal item being considered for change is the nature of the service provided via TDRSS contract. The current contract provides for shared service, i.e., both commercial and NASA service. NASA foresees benefits to changing that service to service dedicated solely to NASA needs. Assessments are being conducted by both sides to determine the nature of the consideration each could offer for such a reformation. NASA will keep the subcommittee apprised of this

situation as it develops.

QUESTION T-7 (d):

The projected ten year TDRSS service cost is $2.3 billion. What is the breakdown between DDT&E and Operatons cost of this figure? Could you provide a runout of these numbers for the subcommittee by next Wednesday?

ANSWER T-7 (d):

The current estimated runout of the TDRSS project is $2.33 billion and is distributed as follows:

1.09	Interest
.15	Launch Vehicles
.82	Development cost and acquisition of ground and spacecraft
.27	Operations, Maintenance and Management
2.33	

This is a fixed price contract for the TDRSS hardware and ten years of operations. Because of this, visibility into an exact breakdown is very difficult. Therefore, the above numbers are our best estimates.

The cost for TDRSS at runout of $2.33 billion will be incurred by payment of approximately $2.15 billion to the FFB to liquidate borrowings and interest with the remaining $.18 billion going to our contractor and for other support costs during the ten year operations period.

QUESTION T-8 (a):

Could you inform the Subcommittee on just what is involved in "turning off a spacecraft" as far as additional acquisition of data is concerned?

ANSWER T-8 (a):

There are essentially two approaches to "turning off a spacecraft." In the first instance, the spacecraft is placed in a standby mode, and in the second case, the spacecraft is permanently silenced.

Both methods are accomplished by ground transmitted command sequences. When a spacecraft is placed in the standby mode, telemetry data transmission from the spacecraft ceases. However, positional tracking requiring a radio carrier from the spacecraft may continue, even though no data is present on the carrier.

On many spacecraft, depending on their degree of autonomy, attitude is generally controlled by on-board spacecraft systems during the period that the spacecraft's telemetry is turned off. However, these on-board control systems

tend to drift over time if the spacecraft is not "turned on" periodically and reoriented (using on-board thrust or other control system capability in concert with precise tracking control and calibration from the ground).

If the spacecraft remains in the autonomous mode of operation for too long, it is possible that the on-board antennas will drift off Earth Point, and the spacecraft will be beyond the control of the ground. If this condition persists, the spacecraft can be lost.

QUESTION T-8 (b):

Do you anticipate having to resort to this process earlier than anticipated?

ANSWER T-8 (b):

No. However, additional budget reductions could force a reduction in operations of some spacecraft.

QUESTION T-8 (c):

How much money can be saved and how do you quantify it?

ANSWER T-8 (c):

The NASA tracking networks consist of general purpose stations which support many different spacecraft. A single spacecraft, therefore, contributes in only a small way to network loading. If significant tracking station staffing reductions were a goal, it would be necessary to close entire stations. This was done in the case of the DSN 26-meter subnet, and will result in an $8 million dollar saving to OSTDS in FY 1983. Further reductions of this nature are not possible in FY 1983, given the projected operational tracking workload.

QUESTION T-9:

If the tracking office had additional funds, where would you anticipate their use?

ANSWER T-9:

The FY 1983 budget funding level is adequate to meet minimal mission support requirements. Additional funds would be used to:

(1) Restore network support capability to relieve the strain in meeting the projected FY 1983 workload. Staffing reductions at tracking stations planned for FY 1983 would be cancelled in order to provide this capability.

(2) Add more aperture for the Voyager Uranus/Neptune extended mission, to improve the basic imaging characterization of these planets.

(3) Enhance the DSN Radio Science capability to ensure that the Voyager extended mission obtains the maximum value from its encounters at Uranus/Neptune. This would be done by modifying the system to improve real-time performance monitoring, reliability, and the overall sensitivity of the system to compensate for the lower signal levels expected at Uranus/Neptune.

QUESTION T-10:

In the Advanced Systems area, are there any more TDRSS type systems waiting to be developed in the years to come?

ANSWER T-10:

Within the last year, a contract was awarded to Stanford Telecommunications Inc., of McLean, Virginia, to study what can or should be done in the 1990's era if we are confronted with an aging, inadequate capacity or unreliable Tracking and Data Relay Satellite System. This study is a preliminary effort mainly to identify alternatives and does not involve development of hardware. When completed, its findings will assist OSTDS in making planning decisions on future studies and developments needed for Earth orbiting spacecraft support in the 1990's era.

Mr. FLIPPO. Thank you, Mr. Smylie.

Mr. Smylie, the Office of Tracking and Data Acquisitions budget has increased over $100 million over the fiscal year 1982 budget. Could you tell us some of the major reasons why that is, and do you anticipate another very large increase for the next budget year?

Mr. SMYLIE. Mr. Chairman, for fiscal year 1983 and the following fiscal year, we will be going through the transition from the existing space tracking and data network and the DSN into the tracking and data relay satellite operation. We will have a great deal of cost associated with the transition in that we are operating both networks and transitioning them in that 2-year period.

The approximate $100 million increase from fiscal year 1982 to fiscal year 1983 is composed of essentially three components. One is the TDRSS payment of $60 million, which is new in the budget and of course was zero in the 1982 budget; about $30 million for inflation, which represents about a 6- to 7-percent rate on those elements of the program that we believe are subject to inflation; and the remainder is primarily related to the other preparations for bringing the tracking and data relay satellite system into operation, chief among those being the software activity at the Network Control Center at Goddard. In fiscal year 1984, there will be another increase, again associated primarily with the fact that we will have a 12-month payment for the tracking and data relay satellite system, which is about a $230 million payment in that year. In 1984, we will begin to close tracking stations. We will, of course, have to pay the termination costs for the people and the termina-

tion costs associated with closing those stations in 1984. In 1985, we should begin to see some relief.

Mr. FLIPPO. Are there any plans to change the present contract structure with Spacecom?

Mr. SMYLIE. I believe we discussed with the Committees informally last year some activities we had ongoing to examine the business relationship and whether there were adjustments that could be made that could make the program more efficient and more businesslike. It was somewhat more related, although not entirely, to one of the recommendations of the Inspector General report of last year. We are continuing the discussions within the administration concerning some options that might change that business relationship, and if any of those reach fruition we would, of course, discuss those in detail with the committees.

Mr. FLIPPO. The projected 10-year service cost, I think, is in the neighborhood of $2.3 billion.

Mr. SMYLIE. Yes, sir.

Mr. FLIPPO. Would you be able to give us the breakdown between DDT&E and operations costs, the runout numbers for the subcommittee say, perhaps, next Wednesday? Would that be too short a time period?

Mr. SMYLIE. We could do that. This program, of course, is sort of unique in its funding arrangements and those terms do not apply in the usual way to R. & D. projects, in that we also carry interest costs and the costs of some of the launches in the program, which are not normally carried as part of D.D.T. & E. for a program. I would estimate at this time that what you might normally call D.D.T. & E. is approximately $800 million of that $2.3 billion. interest costs are about $1.1 billion and the remainder is operations, launch vehicles, and so forth but we can firm that up for you by next week.

[The information follows:]

The current estimated runout of the TDRSS project is $2.33 billion and is distributed as follows:

Interest	$1.09
Launch vehicles	.15
Development cost and acquisition of ground systems and spacecraft	.82
Operations, maintenance, and management	.27
Total	2.33

This is a fixed price contract for the TDRSS hardware and 10 years of operations. Because of this, visability into an exact breakdown is very difficult. Therefore, the above numbers are our best estimate.

The cost for TDRSS at runout of $2.33 billion will be incurred by payment of approximately $2.15 billion to the Federal Finance Bank (FFB) to liquidate borrowings and interest with the remaining $.18 billion going to our contractor and for other support costs during the 10 year operations period.

Mr. FLIPPO. Thank you.

Mr. Hollenbeck?

Mr. HOLLENBECK. Thank you. Mr. Chairman, I had some opening remarks which I did not have a chance to make.

Mr. FLIPPO. Without objection, we will insert those immediately following my own.

Mr. HOLLENBECK. In those remarks, Mr. Smylie, I phrased a couple of questions to you which I will outline now in a series. I think you can answer it with one statement.

My office and my staff receive letters on frequent occasions now from people who are concerned about our exploration of the solar system, particularly with the Pioneer and the Voyager spacecraft. My question to you, my first question is, is your portion of the budget adequately funded for fiscal year 1983 to insure the continued operation of these spacecraft? In the alternative or along that line, will consolidating your various tracking operations and closing some ground stations force us to "turn off" some of these spacecraft?

While you are answering that, maybe you can elaborate on just what would be involved in turning off a spacecraft as far as additional acquisition of data from that is concerned.

Mr. SMYLIE. Let me try to discuss that in several parts. One part of your question was related to, "Is the budget adequate to support the ongoing spacecraft that are now flying and the ones that are coming?" In my opening statement I noted that we closed the 26-meter subnetwork of the DSN during fiscal year 1981 or early 1982. That closure did reduce our capability to support the ongoing planetary missions by about 30 percent.

In those periods of time when the ongoing planetary spacecraft happen to line up in the same part of the celestial sphere, it does create some problems in providing the requested level of support to all of those spacecraft. At other times, when they tend to separate and we can support them from different locations instead of just one location, then the situation gets better. However, all in all, it is a situation where we believe we are providing adequate, though not all of the requested support, to the ongoing spacecraft. Our budget as currently constructed would continue that for the planetary missions. The network consolidation activity will tend in time to improve that situation because we will construct at least two new antennas in the network over time, and will relocate some of the smaller antennas that are currently located in the STDN to the DSN locations. We will be better off or at least as well off in terms of our ability to support the planetary missions and the high earth-orbiters in that timeframe.

In the 1984 timeframe we will close the remaining ground network which supports the Earth-orbiting spacecraft, as the TDRSS comes into being. That is something which has been planned all along. If everything had been on schedule we would have done that already. There are some spacecraft that are flying that are not compatible with the tracking and data relay satellite, and so those spacecraft will either cease to get support at all or they will obtain marginal support from the remaining three stations in the network. Most of these spacecraft will have been flying for many, many years by that time and will have essentially accomplished their mission. In fact, all of them have already. They are in extended mission phases. However, some spacecraft will probably be turned off in the 1984–85 time frame. All that is needed physically to turn off a spacecraft is a command to do that. The management process needed to reach that point gets rather involved. Of prime importance is the value of the data return and cost of continuing

support; therefore, there is a lot of decisionmaking. In my recent experience, we have only turned off one satellite, I believe, that was still operating, and it was the Orbiting Astronomical Observatory. It was turned off in 1980 and had been flying for about 8 or 10 years at the time it was turned off. The sensors had begun to degrade somewhat, although it was still a very well operating spacecraft.

Mr. HOLLENBECK. Thank you.

Mr. FLIPPO. Thank you, Mr. Hollenbeck.

Mr. Smylie, we have some additional questions we would like to submit to you for the record if you can supply those for us.

Mr. SMYLIE. OK. Thank you, sir. We will be pleased to provide answers.

Mr. FLIPPO. Thank you very much for your testimony. We appreciate that.

Our next witness is Dr. Jack Kerrebrock, Associate Administrator, Office of Aeronautics and Space Technology.

STATEMENT OF DR. JACK KERREBROCK, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY, NASA

Dr. KERREBROCK. Mr. Chairman, Mr. Hollenbeck, I am pleased to appear before you today to testify for the first time as the Associate Administrator for Aeronautics and Space Technology.

Mr. FLIPPO. We are delighted to have you.

Dr. KERREBROCK. Thank you.

My division directors are here also to assist me in answering any detailed questions you may have. Before I begin my statement, I would like to introduce two people from the NASA research centers who are working with us in the space research and technology (R. & T.) area at headquarters for a year as part of the NASA career and development program: Mr. Harry Benz, who is from Langley Research Center, is working with information systems programs, and Mr. Dennis Flood from the Lewis Research Center is working with space power and electric propulsion programs.

With your permission, I too would like to summarize my formal statement, which is submitted for the record.

It is my view that the space research and technology (R. & T.) program should serve to maintain a technical disciplinary base not only for NASA missions but for the rapidly expanding military and commercial space efforts of this country, as well. While the military and commercial segments perform applications research and development to implement technology in flight systems, it is NASA's unique role to explore at the more fundamental level the potential of emerging technologies.

This responsibility dictates that the space R. & T. program address a broad range of fundamental research critical to present and future space activities and explore opportunities for advancing the most important technologies. This breadth of activity is indicated on figure 1, which suggests basic research disciplines across the top of the chart and systems research, on critical system elements across the bottom of the chart. All the work carried out complements and supports that done by the user-oriented offices of NASA.

We will continue to insure that these efforts serve the commercial and military satellite communities as well.

The space research and technology budget contains three line elements, as indicated on figure 2. The budget element of standards and practices provides for agencywide support from our Office of the Chief Engineer. The budget request of $120 million for the research and technology base and systems technology elements is 11 percent above the current fiscal year 1982 estimate, which allows for a small amount of real growth.

Our strategy for best utilizing these critical resources has been described in previous years' testimonies as giving the highest priority to the basic work carried on in the R. & T. base. Over the past decade, this prioritization has resulted in a lower level of effort in the systems technology effort, which is projected as $4.4 million, where the objective is to bring technology to the state where it can be considered suitable for application with moderate risk. It must be recognized that this function must be provided by other NASA program offices or by the military and commercial sectors, if it is not conducted as part of the space research and technology program.

As shown in figure 3, the Ames, Langley, and Lewis Research Centers now report to the Office of Aeronautics and Space Technology. That is the new organization of NASA Headquarters. Having the institutional responsibility for the research centers permits my office to formulate and manage the construction of facilities and research and program management budgets, as well as the aeronautics and space R. & T.

The magnitude of the added institutional responsibility is, figure 4 about equal to the R. & D. budget. The total program resources supporting the space technology budget is $213 million for fiscal year 1983. These resources are disposed by the research and the flight centers of NASA, in the proportions shown on the figures which also depicts the technical emphases at each center. The spectrum of capabilities provided by the research and flight centers provides a balance in both the disciplinary work and in applications-oriented tasks.

I would like now to selectively describe some of the programs for fiscal year 1983, some of the accomplishments of this past year, and how our programs support our planning goals. Of particular note this year are the many space flight technology experiments that have been flown and the many others being readied for future flights. The tasks are organized, as they have been in previous years, in the groupings of transportation, information, and spacecraft.

Efforts in support of transportation systems are directed both toward evolutionary improvements to current NASA systems such as the Shuttle and toward the development of wholly new concepts. This technology activity covers a broad disciplinary base and spans the transportation needs of Earth-to-orbit, orbit-to-orbit, and planetary transfer stages. I will discuss some items in flight experiments, thermal protection systems, and some Shuttle main engine improvements. The Space Shuttle provides an unprecedented opportunity to obtain flight research data on the performance characteristics of a space transportation vehicle, data which is unavail-

able from simulations in ground test facilities and which is essential to a full understanding of Shuttle performance and to the validation of design tools.

We have a unique model of the Space Shuttle Columbia, and I have asked Mike Cuviello to point out some of the features as I go. The model is unique in that it features many important OAST technology experiments. With the successful Columbia flights, we had an special sense of pride because of the many contributions we feel our office made to its development. Prior to initiation of the development, our office managed extensive efforts in advanced technology and design activity supporting this national venture. Our early works on aerodynamics, propulsion, controls, power sources, materials, and structures provided important inputs to the final design and ultimate success of this vehicle. For example, aerodynamic test facilities in the research labs were utilized in excess of 60,000 hours in design and development testing prior to flight. Our inventions of thermal protection systems, their coatings, and installation methods were crucial to the successful reentry performance of this vehicle. The famous tiles are the best-known part. Our work on advanced propulsion technology laid the foundation for the powerful hydrogen/oxygen main engines which provide thrust from lift-off to near-orbit insertion.

In addition to these contributions to the development of the Shuttle, we are pleased to have conceived and implemented a flight research program that affords investigators an early opportunity to better understand Shuttle performance and environments. Our orbiter experiments program provided instrument packages which flew on the first Shuttle flight.

I would invite your attention to the model after the hearing if you like but let me point out some of the experimental packages that have already flown aboard the orbiter, as well as several planned experiments which are displayed on the model. The aerodynamics coefficient identification package is a little red package down in the bottom which you cannot see. This is one interesting feature of these experiments: They are all very small and were developed as part of the orbiter experiments program to acquire precise flight dynamic data and assess the aerodynamic characteristics of the vehicle. Using STS–1 entry data obtained in this experiment, it has been possible to determine the source of an unexpected vehicle oscillation and to provide vital corrective measures for future flights.

On the second flight, we incorporated two additional orbiter experiments to investigate the catalytic surface effects and tile gap heating. These are on the bottom heated region of the Shuttle. From the results of this highly successful experiment, we have concluded that standard Shuttle tiles do not behave catalytically and that they, therefore, experience less severe heating than was expected. Future flights will be able to function under more severe entry conditions in the light of this information. The other experiment provided the first research quality flight data on the effects of tile gaps and adjacent radii. All three of these orbiter experiments will be continued in future flights.

In addition, new experimental packages will be added in fiscal year 1983. These packages are also displayed on the model. A spe-

cially instrumented nosecone will provide aerodynamic data at altitudes below 300,000 feet. A mass spectrometer, which is also at the base of the nosecone, will be added to provide data at higher altitudes. An infrared sensor will be mounted here on a special tail pod on the orbiter to give the upper surface temperature measurements by infrared sensing technique.

The ongoing research program on thermal protection systems is directed at materials of greater durability, longer life, and easier maintenance. A new high strength, fibrous ceramic material capable of withstanding higher temperature and with enhanced toughness has been characterized and fabricated into tiles for test and evaluation. Initial research studies on a new TPS concept using large sheet, carbon-carbon composite material offers the potential of significantly increased life. Research on damage-tolerant metallic systems has led to the successful thermal exposure of a multiwall titanium insulation material—exposure in ground tests, that is—and design interactions are underway. In fiscal year 1983, extensive thermal ground tests will aid in evaluating these and other concepts.

A major propulsion effort is aimed at significant extensions in the life and performance of the Space Shuttle main engine, the SSME. Initial work is leading to a better understanding of engine component life. Analytical models are being developed to described engine behavior, and include the following: the dynamics of turbopump rotating machinery; behavior of high-speed bearings in cryogenic systems; flow distribution and dynamics of hot gases in the injectors; and structural dynamics of the engine. This knowledge will be employed to develop life prediction techniques and life extension programs. New materials fabrication processes and diagnostic techinques are being explored, including powder metallurgy, ceramic coatings, crack detection techniques, and sensing techniques for incipient failure detection.

The information systems research and technology program provides advanced sensor, data, and communications technology options for earth resources, environmental observations, and space science missions, as well as for the Agency's thrust toward a permanent manned presence in space.

These efforts focus on efficient and timely acquisition, processing, reduction, and distribution of space-acquired information extensive experimental data, both flight- and laboratory-derived, is being acquired and applied jointly with our flight offices. I will describe only two activities: the onboard processing of data and satellite communications technology.

Shown on the model are the feature identification and location experiment. Its purpose is to spectrally sense and quantitatively assign the Earth's surface to four classes—vegetation; bare earth; water; and the fourth category, cloud cover, snow, and ice. Real-time onboard image classification was achieved for the first time on STS–2. A reflight of this experiment is planned on OSTA–3 to gather statistical data at improved Sun angles. This experiment and supporting laboratory results a real designed to reduce the cost of data processing by allocating more of the job to onboard systems.

We plan to continue the development of advanced communications technology at our Lewis Research Center. The development of

critical technologies to alleviate the saturation of presently usable frequency bands will be pursued through more efficient utilization of existing bands and expansion into new frequency bands such as 30/20 gigahertz.

An important research achievement in traveling wave tubes, which are currently beset with production and cost problems, is the tunneladder tube, a potentially inexpensive and highly producible alternative to the conventional high-power traveling wave tube. Ladder structures have been fabricated and the first 29 gigahertz tube is expected to be built this fall. Plans for fiscal year 1983 call for the fabrication and test of a 40 gigahertz space-based tube.

In the area of spacecraft technology, the technology for future large space systems and for Earth-orbiting and planetary spacecraft is the objective. I will highlight large space systems activities and some spacecraft-related flight experiments.

The materials and structures research program includes the development of new concepts for erectable and deployable large space systems. One concept for space erection of structures was recently evaluated in the neutral bouyancy facility at the Marshall Space Flight Center. Plans for fiscal year 1983 are to generate structural designs, deployment schemes, and packaging techniques that could be used to test a possible future 200-meter, automatically deployed antenna. Another element of the large space system technology program deals with large antennas, in which proof of concept will be demonstrated in a ground test. By deployment of four gores or segments of a 50-meter mesh antenna reflector, we hope to verify the mechanism design, understand mesh deployment, and evaluate the mesh surface precision. Testing will begin in fiscal year 1982 and will continue into fiscal year 1983. Increased autonomy offers the potential for large cost reductions in space craft operations and for reduced dependence on ground control. considerable commonality exists with Air Force needs for space autonomy and joint acitivities are being vigorously explored. During the last Voyager encounter, an autonomous optical navigation experiment was successfully accomplished. In the planning period we will initiate technology development for autonomous thermal, attitude control, and power subsystems. An all-up system ground demonstration could be available by 1986.

A flight test article of the ion auxiliary propulsion system is in final system test. This thruster system is suitable for north-south stationkeeping of geosynchronous military and commercial communications statllites. NASA is scheduled to deliver the flight hardware to the Air Force this spring for integration into its Teal Ruby Spacecraft, which is scheduled for launch in 1983 under an interagency memorandum of agreement.

More such opportunities are being sought for cooperative efforts between NASA and the military. In the latest NASA/USAF interdependency meeting held this past January, teams of experts assessed high-priority mutual technology interests derived from the NASA and military space system technology models. Formal memoranda of agreement either already exist or are being generated for exchange of data in some 25 activities. Efforts are proceeding to select a half dozen for intensive, jointly planned and conducted programs. The product of this interactive process will be a NASA

space research and technology program that serves as a national resource.

In summary, I wish to underscore my conviction that this technology program will generate high-quality additions to the Agency's reservoir of space system design options. It provides for less systems research than was projected in last year's authorization testimony but it represents what we consider to be a judicious application of scarce resources.

Mr. FLIPPO. Doctor, we are very pleased to have a man of your experience and background in this position.

Dr. KERREBROCK. Mr. Chairman, I did want to comment briefly on energy, if I may.

Mr. FLIPPO. All right. Please feel free.

Dr. KERREBROCK. If you would like to ask questions now, that would be all right.

Mr. FLIPPO. No, we will wait until you conclude.

Dr. KERREBROCK. I will proceed with just a few words about the activities that support the national energy programs.

Although in past years, there has been NASA-funded energy work, we are not requesting funds for this purpose. Our energy involvement now consists solely of supporting DOE and other agencies on a reimbursable basis, by conducting energy research and technology. These efforts have been underway for approximately 10 years, and progress has been underway for approximately 10 years, and progress has been made in many important technology areas. Four of these programs are illustrated on Figure 6: the large wind turbine development; photovoltaic systems at the top there; fuel cells over at the right; and advanced heat engines, with the example shown being the Detroit Diesel-Allison enry in automotive gas turbines.

Industrial involvement in these programs has been an important key to the accomplishments that have been made. Large wind turbine technology has progressed to the point that utilities are considering them for new electric power generation capacity. Photovoltaic systems have been deployed in this country and abroad to provide electric power for specialized applications. Although the cost is still many times that of more conventional means of power generation, the cost of these systems, most importantly, the cost of the solar cells, has been coming down steadily. With DOE and the Gas Research Institute, we have begun the purchase of 45 fuel cell units that will be deployed throughout the country to provide operating experience with these efficient, clean, electric-power-producing systems. The automotive gas turbine holds the promise of high efficiency and a technological jump ahead for our auto industry.

These are just a few examples of the technology areas we have been supporting over the past years. To date, our role in the development of advanced technology for terrestrial energy has come at the request of the agencies directly involved and by Congress. With continuing reductions in civil service manpower, these efforts do detract somewhat from our ability to carry out our responsibilities for aerospace research.

We have attempted to minimize this impact by choosing areas of activity which produce technology advances of potential benefit to aeronautics and space. However, as we look ahead we find it will

be necessary for NASA to phase out its civil service manpower support to reimbursable energy work by the end of fiscal year 1983 in order to more appropriately devote the available manpower to our traditional programs.

The Jet Propulsion Laboratory will continue to provide support to energy areas where they have the capabilities required to successfully accomplish program goals. I want to assure this Subcommittee that we will structure this transition in coordination with the sponsoring agencies, such that the investments that have been made will be protected and an efficient transition to new management will be carried out where appropriate.

That completes my remarks.

[The prepared statement, plus answers to questions asked of Dr. Kerrebrock follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
MARCH 3, 1982

STATEMENT
of
Dr. Jack L. Kerrebrock
Associate Administrator for
Aeronautics and Space Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to represent the Office of Aeronautics and Space Technology (OAST) and to present to you the proposed NASA Space Research and Technology and Energy Technology Programs and the associated budget requests for Fiscal Year 1983. Considering that there was no Preauthorization Hearing, I shall also describe some significant recent accomplishments.

SPACE RESEARCH AND TECHNOLOGY

It is my view that the Space Research and Technology (R&T) program should serve to maintain a technical disciplinary base of value not only to future NASA missions but for the military and commercial space efforts of this country as well. While the military and commercial segments perform applications research and development to implement technology in flight systems, it is NASA's unique role to explore, at the more fundamental level, the potential of emerging technologies. This responsibility dictates that the Space R&T program address a broad range of research critical to present and future space activities and to explore opportunities for advancing the most important technologies.

This breadth of activity is illustrated in Figure 1, which shows basic research in the disciplines of information processing, space power and electric propulsion, chemical propulsion, electronics and automation, materials and structures, and aerothermodynamics (or reentry aerodynamics). Systems research on critical space systems elements are also shown including information, spacecraft, and transportation systems. All work carried out by OAST complements and supports that done by the user-oriented offices of NASA. We are endeavoring to ensure that it also serves the commercial and military satellite communities as well.

The Space Research and Technology budget consists of three line elements which are illustrated in Figure 2. The budget element of Standards and Practices provides for the necessary agencywide support from our Office of the Chief Engineer. The budget request of $120 million for the Research and Technology Base and Systems Technology elements is 11 percent above the current FY 1982 estimate, allowing for a small amount of real growth. Our strategy for best utilizing these critical resources has been described in previous years' testimonies as giving the highest priority to the basic work carried on in the R&T Base. Over the past decade this prioritization has resulted in a lower level of effort in the Systems Technology element whose objective is to bring technology to the state where it can be considered suitable for application with moderate risk. Therefore, the responsibility for systems technology development would need to be assumed by the particular user program.

As has been explained in previous testimony, NASA's organizational structure has been changed so that Field Centers report to the three program Associate Administrators. The new organization is depicted in Figure 3. The change was made to establish a clear distinction between line and staff functions at Headquarters and to improve the utilization of the centers. The Ames, Langley, and Lewis Research Centers now report to this office. Having the institutional responsibility for the Research Centers permits this Office to formulate and accept overall management responsibility for Construction and Facilities (CofF) and Research and Program Management (R&PM) budgets as well as managing the Aeronautics and Space R&D. The magnitude of the added institutional responsibility for OAST is illustrated in Figure 4. As shown on the right, total program resources supporting the Space Technology budget are $213 million. It should be emphasized that about 35 percent of these resources are provided to the Flight Centers, where a knowledge of system application needs and opportunities enhances the process of technology transfer. The spectrum of capabilities provided by both the Research and Flight Centers, shown in Figure 5, provides a balance in both the disciplinary sense as well as in the research and applications-oriented tasks.

I should like now to describe the programs for FY 1983, some accomplishments of this past year, and how the programs support our planning goals. The tasks are organized, as they have been in previous years, in the groupings of transportation, information, and spacecraft. The activities that support these categories are conducted within the disciplinary and systems related research areas identified in Figure 1. It is not intended to detail all activities, but rather to selectively portray the character and quality of the program. Of particular note this year are the many OAST space flight technology experiments that have been flown and the many others being readied for future flights.

Transportation Technology

The technology efforts in support of advanced transportation systems are directed to both the near-term objective of supporting potential evolutionary improvements to current NASA systems and the far-term objective of enabling the development of wholly new concepts. This technology activity extends across a broad multi-disciplinary base and spans the transportation needs of Earth-to-orbit, orbit-to-orbit, and planetary-transfer stages.

The two Space Transportation System (STS) flights brought to fruition a long period of planning and preparation for the OAST Orbiter Experiments (OEX) Program. The Space Shuttle provides an unprecedented opportunity to obtain flight research data on the performance characteristics of a space transportation vehicle. These data, unavailable from simulations in ground test facilities, are essential to a full understanding of Shuttle performance and to the validation of tools, both analytical and empirical, used to design the Shuttle. These OEX program results will enable improved future designs, cost-effective utilization of test facilities, and expansion of the Shuttle's operational capabilities. OEX flight experiments in support of research efforts in aerodynamics, thermal protection systems, and payload environment will continue through FY 1982 and FY 1983. Instrumentation will be added to expand the current capability for broadening the flight research data and analysis programs. Examples include: an on-board instrumentation pod to measure upper wing and fuselage heating; a high-resolution accelerometer package to characterize upper atmosphere aerodynamic performance; a mass spectrometer to further aid in upper atmosphere characterization and a low altitude instrument set to provide very high accuracy measurements of Orbiter velocity and attitude.

Measurements on the Shuttle Orbiter's Thermal Protection System (TPS) were obtained on both STS flights. Flight data were taken to verify the performance of TPS subsystem elements, namely the ceramic tiles, glass coating, and tile gap fillers. Initial analysis of STS-2 flight data indicates that the tile surface temperatures were significantly lower than the design criteria, except for those tiles which were coated to induce the catalytic behavior which was assumed in the design. These effects could not be confirmed in ground facilities. These findings will permit expanded cross-range capability in future Orbiter flights. Plans include a continuing effort to obtain accurate temperature maps of the Orbiter's surfaces.

Orbiter surface temperature data obtained in flight show the location of laminar to turbulent boundary layer transition. More extensive data will be obtained from future flights. Computational procedures and techniques have been developed for analyzing these data. Other on-board Orbiter experiments, including upper-atmospheric

density measurements, Shuttle nose pressure measurements, and aerodynamic coefficients, will provide for comparative analysis of force and control characterization. These experiments provide research-quality data for evaluating and improving theoretical and ground-based experimental methods, leading to improved future vehicle designs.

The Dynamic, Acoustic, and Thermal Environment (DATE) program is another element of the Orbiter Experiments Program. DATE, a jointly funded NASA/Air Force program, will provide data on the dynamic, acoustic, and thermal environment in the payload bay. The recorded flight information will be used to derive realistic payload design and test criteria, to validate analytical predictive methods, and to develop techniques to assess combined vibration and acoustic load effects on payloads. Data from STS-1 and STS-2, while still being analyzed, indicate that the payload bay environment is more benign than assumed by current design criteria. This will help alleviate risks for spacecraft planning to use the Shuttle. Additional DATE measurement packages are planned for STS-3, 4, and 5.

With the valuable insights being gained from OEX data, it is timely and feasible to consider technology improvement programs that will offer significant improvements to the Shuttle. The current Space Transportation System is expected to be the nation's principal access to space through the turn of the century. With the introduction of improved technology, it will be possible to effect a more reliable, versatile, and cost-effective system. Options are being studied and technology is being generated for: extending life and performance of the Orbiter main engines; developing more durable thermal protection systems; streamlining mission planning and execution through automation; and more sophisticated design optimizations of such elements as the external tank thermal protection.

The ongoing research program on thermal protection systems is directed at materials of greater durability, longer life, and easier maintenance. A new, high strength, fibrous ceramic base material capable of higher temperature and with enhanced toughness has been characterized and fabricated into tiles for test and evaluation. Initial research studies on a new TPS concept using large sheet, carbon-carbon composite material offers the potential of significantly increased life. Research on durable systems, based on the inherently higher damage tolerance of metals, has shown considerable promise with the successful thermal exposure test of a multiwall titanium insulation material. Design iterations are underway. In FY 1983, continuing extensive thermal ground tests will aid in evaluating these and other concepts.

The Earth-to-orbit propulsion technology program is aimed at significant extensions in life and performance of the Orbiter main engines. Initial work is leading to a better understanding of engine operating environments and assessing the effects on engine component life. Analytical models are being developed to describe: the dynamics of turbopump rotating machinery; behavior of high speed bearings in cryogenic systems; flow distribution and dynamics of hot gases in the injectors; and structural dynamics of the engine. This knowledge will be employed to develop life prediction techniques and life extension programs. New materials, fabrication processes, and diagnostic techniques are being explored including: powder metallurgy; ceramic coatings; crack detection techniques; and sensing techniques for incipient failure detection.

The payload capability of possible future reusable transfer vehicles to geosynchronous orbit could be substantially increased by using an aerodynamic braking technique to facilitate return to low-Earth orbit. Preliminary assessments indicate that orbital transfer vehicle payloads might be doubled. In FY 1983, continued emphasis will be placed on: predicting vehicle flow fields and performance; improving ground-based experimental techniques; and developing a ground and flight test data base for aerodynamic maneuvering vehicle design.

Future systems will face requirements ranging from high acceleration roundtrip transfers for resupply, to very low acceleration one-way transfers of large, flexible structures. A variable thrust propulsion technology program is directed towards providing high performance over a broad throttling range for orbital transfer vehicles operating between low-Earth orbit and geosynchronous orbit. With current engines, significant performance loss occurs at low thrust levels. FY 1983 technology plans include the development of key technologies for efficient, variable flow turbopumps and for stable, high pressure, high performance combustors.

The transportation technology programs, represented by these elements, are seen to rely heavily on flight and ground experiments and are expected to help in the successful evolution of an improved national space transportation system.

Information Technology

The information systems research and technology program provides advanced sensor, data, and communications technology options that will enable and enhance systems for Earth resources, environmental observations, and space science missions, as well as provide technology for the Agency's thrust toward a permanent manned presence in space. These technology options focus on efficient and

timely acquisition, processing, reduction, and distribution of space-acquired information. Extensive experimental data, both flight and laboratory-derived, is being acquired in this technology area and applied, jointly with our user flight offices, to program applications.

The objective of the Feature Identification and Location Experiment (FILE), flown on STS-2, is to develop and evaluate an instrument capable of spectrally sensing and quantitatively classifying the Earth's surface into identified picture elements in each of four classes: vegetation; bare Earth; water; and cloud cover, snow, and ice. This instrument classifies scenes and counts the number of picture elements, pixels, in the scene for each class. It then assigns the scene to the class whose pixels predominate. The scene is also recorded photographically including the intensity of each of the two band images for each pixel in the scene. Real-time image classification was achieved for the first time on STS-2. A reflight of this experiment is planned on OSTA-3 to gather statistical data at improved sun angles. A magnetic bubble recorder, as backup to the tape recorder, may also be incorporated.

Improved sensing techniques for measuring rare gas elements in Earth and planetary atmospheres would be an important advance. A laser heterodyne spectrometer, using tunable diode lasers as local oscillators, is being constructed for an aircraft flight verification of the concept. Operation requires that precise wavelength identification be made by comparing the measurement data with the signature of a known gas contained in a cell within the instrument. Very high resolution and the capability of simultaneously measuring two atmospheric trace species are required. During FY 1981, a laboratory model was fabricated and tested including the cooler and star tracker subsystems. Measured performance was favorable and a flight prototype will be assembled, tested, and calibrated during FY 1982. Flight readiness is targeted for late 1982 following shipment to Ames Research Center and installation aboard the GV-990 "Flight Laboratory."

New means are required for reducing the increasingly large quantities of data acquired in space. A real-time signal processor which exploits the phenomenon of light scattering in solids by acoustic waves has been built. This acousto-optic processor has six times the frequency resolution of ordinary filter banks at a tenth of the weight and power consumption. It will be experimentally tested by ground-based processing of signals acquired from terrestrial, solar system and galactic observations. The ultimate advantage of this concept is that it can be constructed on a single, solid-state chip to eventually enable real-time, on-board signal processing with dramatically small power consumption, negligible weight and size. During the next fiscal year, this chip design will undergo experimental development.

Another step in the efficient management of space-acquired data relates to format improvement. Advanced data system studies have concluded that space-acquired data in "packet" form should be an integral part of long-term NASA data system architectures. Standardizing packet data accomplishes: reduced costs by automation; elimination of unique hardware and software; simplified quality control; deterministic data accountability; autonomous instrument formatting; and consistent interfacing throughout instrument life. Packet guidelines were approved and distributed to NASA program offices and a packet transmission was emulated via NASCOM from JPL to GSFC. During this fiscal year, ground software will be completed followed by a demonstration of prototype flight hardware in FY 1983. The Office of Tracking and Data Systems will be introducing the technique, as described in their testimony, in the Space Telescope Program. The International Solar Polar Mission (ISPM) has chosen to apply the packet techniques and nine other programs are assessing its use.

Space communications depend heavily on the use of the Traveling Wave Tube (TWT), but the technology for its reproducible fabrication has been beset with production and cost problems. The "tunneladder" slow-wave circuit is a potentially inexpensive alternative to the conventional coupled-cavity, high power TWT. The tunneladder circuit consists of one or more ladder-like arrays of conductors arranged to form a waveguide. Its improvement potential is derived from the fact that the ladder and the outer shell are produced separately, permitting a variety of fabrication techniques to be employed. Upon assembling a tunneladder circuit tube, only a few relatively large parts need to be brazed, in sharp contrast to a coupled-cavity TWT which consists of hundreds of machined parts. A program is underway to develop a low-cost, 29 GHz TWT for use in terrestrial transmitters. This technology base could also be applied to communication spacecraft systems in the 30/20 GHz range. The first ladder structures have been fabricated and the first 29 GHz tube is expected to be built this fall. Plans for FY 1983 call for the fabrication and test demonstration of a 40 GHz space-based tube.

It is, I hope, evident that the demands of the next decade for exponentially increasing quantities of data, and more importantly, useful information are being addressed by the Information Technology program.

Spacecraft Technology

Spacecraft technology provides the focus for the development of future large space systems and Earth orbiting and planetary spacecraft. The foundation for these developments is the disciplinary activities in materials, structures, power, propulsion, controls and automation. They also depend on basic research in physics and chemistry to

develop fundamental understanding of behavior and predictive methods for component performance. Mission and systems analyses identify technology and research options and opportunities. Validation of systems performance is accomplished through integrated systems tests, both ground and space-based, and such will dominate our report this year.

The materials and structures research program includes the development of new concepts applicable to possible future erectable and deployable large space systems, supported by analysis, design, and experimental validation techniques. Truss structures are being emphasized because they provide high stiffness as well as surface accuracy. A Langley Research Center concept for space assembly of structures, too large or complex to fold and deploy, was recently evaluated in the Neutral Buoyancy Facility at the Marshall Space Flight Center. Pressure-suited astronauts assembled a 36-element truss using five-meter long nestable struts made of graphite epoxy. Total assembly time of 35 minutes permits a prediction of only 45 seconds per member for the space environment. Plans for FY 1983 are to generate structural designs, deployment schemes, and packaging techniques that could be used to test a possible future 200-meter sized planar structure that could be carried into orbit and automatically deployed.

Another element of the large space system technology program deals with large antennas in which proof of concept will be demonstrated in a ground test. By deployment of four gores of a 50-meter diameter antenna reflector, we believe we can verify the mechanism design, understand mesh deployment, and evaluate the mesh surface precision. The construction of test hardware and of the test set-up is underway. Testing will begin in FY 1982 and continue into FY 1983. There are two competing concepts, "wrap rib" and "hoop column," which will be evaluated in the test program.

The construction, repair, and maintenance of space systems require a vigorous program of developments in teleoperators and robotics. The immediate program focus is the development of supervisory robotics control with sensory feedback. Fundamental research on stereo computer vision for real-time robot control is progressing toward a 1986 major capability demonstration, and approaches for supervisory control of complex robot tasks are being developed. During the past year, a proof-of-concept demonstration in stereo tracking was accomplished by use of an image feature extractor which enables visual tracking at 15 frames a second.

The Induced Environment Contamination Monitor program was initiated in response to user concern about STS contamination to optics, solar cells, and heat transfer surfaces. The monitor is a composite of ten instruments that measure

the STS environment during all phases of Shuttle operation from preflight through postflight. Installed in the Orbiter payload bay, the equipment was successfully flown on the STS-2 mission. The results are encouraging with preliminary indications that contamination levels are within the requirement goals. The monitor flown on STS-2 has been refurbished and is currently installed in the STS-3 Orbiter bay awaiting flight. STS-3 and STS-4 missions are planned for longer duration. In FY 1983, the instrument will also be carried on STS-10, the first Spacelab mission.

Studies of possible future large space systems such as the Applications Platform, the Space Operations Center, and space stations continue to identify the need for improved energy storage. The fuel cell/electrolyzer offers potential weights one-half that of Ni-Cd storage batteries. This concept integrates two advanced technologies, fuel cells and water electrolysis, into an efficient energy storage system. A test model will be received during FY 1982 and an alternative design concept test model in FY 1983. After comparative evaluations, engineering development will be undertaken with technology readiness expected by 1986.

Both civil and military forecasts show possible future space missions could require large amounts of power at high power densities, which are radiation-resistant and operate for long periods of time. DOE has been researching a space nuclear reactor with NASA focusing its efforts on critical technologies for the conversion of reactor thermal energy to electrical power. Research in thermoelectrics, during the past year, has resulted in identifying improved high temperature materials which have potentially high efficiency levels. Plans also include an effort to develop technology to improve heat conduction from the reactor core to the thermoelectric elements by using high temperature heat pipes. These critical technology developments and the DOE work on the reactor core are essential to providing a basis for future consideration of this power system option.

Highly autonomous spacecraft offer the possibility for all mission classes to potentially effect large cost reductions in spacecraft operations and to reduce dependence on ground control. Spacecraft functions and operational timelines, which can be automated, have been identified and a plan generated to proceed with technology development. Considerable commonality exists with the Air Force needs for spacecraft autonomy, and joint activities are being vigorously explored. During the last Voyager encounter, an autonomous optical navigation experiment was successfully accomplished. In the planned period we will initiate technology development for autonomous thermal, attitude control, and power subsystems. By FY 1984, a ground test verification program will be initiated for demonstrating the integration of computers,

sensors, actuators, and algorithms into autonomous subsystems. An all-up system ground demonstration could be available by 1986.

A flight test article of the Ion Auxiliary Propulsion System is in final systems test. It will be flown to verify, in space, the functional operation and life of a one millipound thruster, and to obtain in situ measurements of efflux particles and electric fields. This thruster system is, for example, suitable for north-south station-keeping of geosynchronous military and civilian communications satellites. NASA is scheduled to deliver the flight hardware to the Air Force this spring for integration into the Teal Ruby Spacecraft, scheduled for launch in 1983 under an interagency memorandum of agreement.

Mission/technology references, in the form of space system technology models, provide an ideal basis for joint planning and analysis efforts, and ultimately more effective NASA/Air Force Interdependency. In the latest interdependency meeting held this past January, joint expert teams assessed mutual technology interests derived from the NASA and military models. This led to a prioritized list of potential joint programs. While formal memoranda of agreement exist or will be generated for exchange of data in some 25 activities, efforts are proceeding to select a half-dozen for intensive, jointly planned and committed programs.

The process of interactive technology planning requires extensive activity both internal and external to NASA and yields: a broad knowledge base of capabilities and forecasts; a means for accomplishing technical and management peer review of programs; a nationally coordinated program that precludes voids and overlaps between NASA, industry, academia, and other government agencies; and contributes significantly to the effective transfer of technology from developer to user. The previous discussion of NASA/Air Force interdependency is illustrative of the benefits that can accrue from these exchanges. The product of this interactive process is the assurance that the NASA Space Research and Technology Program serves as a national resource filling not only NASA's future mission needs but those of the military and commercial sectors.

ENERGY TECHNOLOGY

And now, Mr. Chairman, I would like to close by saying a few words about our activities that support national energy programs.

Although in past years there has been NASA-funded energy work, we are not requesting funds for this purpose and our energy involvement now consists solely of supporting DOE and other agencies, on a reimbursable basis, by conducting energy research and technology. These efforts have been underway for approximately ten years and progress has been made in many important technology areas. Four of these programs are illustrated in Figure 6, large wind turbine development, photovoltaic systems, fuel cells, and advanced heat engines, with the example shown being the automotive gas turbine. Industrial involvement in these programs has been an important key to the accomplishments that have been made. Large wind turbine technology has progressed to the point that utilities are considering them for new generation capacity. Photovoltaic systems have been deployed in this country and abroad to provide electric power for specialized applications. Although the cost is still many times that of more conventional means of power generation, the cost of these systems and, most importantly the cost of solar cells themselves, has been coming down steadily. With DOE and the Gas Research Institute (GRI), we have begun the purchase of 45 fuel cell units that will be deployed throughout the country to provide operating experience with these efficient, clean, electric power-producing systems. The automotive gas turbine holds the promise of high efficiency and a technological jump ahead for our auto industry. These are just a few examples of the technology areas we have been supporting over the past years.

To date, our role in the development of advanced technology for terrestrial energy has come at the request of the agencies directly involved and the Congress. With continuing reductions in civil service manpower, these efforts detract somewhat from our ability to carry out our responsibilities for aerospace research. We have attempted to minimize this impact by choosing areas of activity which produce technology advances of potential benefit to aeronautics and space. However, as we look ahead, we find it will be necessary for NASA to phase out its civil service manpower support to energy by the end of FY 1983 in order to more appropriately devote the available manpower to our traditional programs. The Jet Propulsion Laboratory will continue to provide support to energy areas where they have the capabilities required to successfully accomplish program goals. I want to assure this Committee that we will structure this transition in coordination with the sponsoring agencies such that the investments that have been made will be protected and an efficient transition to new management will be carried out where appropriate.

INFORMATION SYSTEMS
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CHEMICAL PROPULSION
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NASA
OAST
NASA HQ RS81 87(3)
Rev 1 25-82

Figure 1

RESPONSES TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE HEARING BEFORE THE HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS ON MARCH 3, 1982, TO DR. KERREBROCK.

QUESTION R-1:

Last week Mr. Augustine of AIAA identified what they consider a lack of work on liquid propulsion technology. In the FY 1982 authorization we had stressed that you work in this area. Your FY 1983 request is for $15.5 million. Is this adequate? What is the balance between in-house and contractor efforts?

ANSWER R-1:

We believe that our FY 1983 request for $15.5. million in liquid propulsion technology is adequate to provide the technology advances needed to meet critical future mission requirements. The program includes technology for improvements in the life and performance of the Space Shuttle Main Engine (SSME) that will enhance Shuttle performance and reduce transportation costs, and for advanced reüsable propulsion systems for high performance orbital transfer vehicles that may be needed in the mid-1990 time period (See Question R-7 answer).

Internally, adjustments within the ongoing Space R&T program have been made to improve the balance between other discipline technologies and liquid propulsion.

About $10 million of the requested funds will go directly to industry and universities. While this level of funding cannot by itself maintain the liquid propulsion industrial base (only new business can accomplish that), it can and is intended to retain a competitive environment while critical technologies are being advanced that will be needed for new propulsion procurements when they occur.

The remainder of the funding request will be used to support our in-house program. We believe that this in-house activity is vital in that it preserves a national capability within the Government that will be essential for future support of the Space program in the critical area of liquid rocket propulsion.

QUESTION R-2:

We notice activities in your budget for technology for communications satellite in the 30/20 GHz area. Is the United States doing all it can or should be doing to keep ahead of other nations in this important area? Do you think the United States should fly a 30/20 GHz demonstration satellite? If so, when?

ANSWER R-2:

The United States is doing all it should do to insure U.S. leadership in the highly competitive 30/20 GHz frequency band. NASA's communications technology research and development efforts are being directed toward the high-risk technology areas which are so long range and basic that the U.S. private sector communications companies find them too difficult or risky to address.

System level testing of these new technologies will require extensive testing including a flight test in order to complete the development process, which is beyond the purview of OAST. The timing of a flight test depends on when the technology is ready. From industry's point of view, presumably the timing depends on when they decide to adapt the technology which in turn is determined by the marketplace. We are advised that the Japanese and the Europeans plan to fly technology comparable to that which we are developing in 1988.

QUESTION R-3:

What efforts do you have underway in support of technology for Direct Broadcast Satellite (DBS)? In the land mobile satellite area?

ANSWER R-3:

The Office of Aeronautics and Space Technology (OAST) efforts in base research and technology development for communications are generic in nature and as such are applicable to a wide range of frequencies including the 12 GHz downlink frequency band for Direct Broadcast Satellite (DBS) and lower frequencies for land mobile. A specific example of our work applicable to DBS would be our long life cathodes research which may prove to be essential for the high power traveling wave tubes required for DBS. Our large antenna and controls technology is directed primarily at the land mobile area.

QUESTION R-4:

A continuing or even worsening problem with the advent of sensors like the Thematic Mapper is the tremendously increased amounts of data which must be handled. What efforts do you have underway in this area? Do you feel NASA or someone else should be doing more? What else could you be doing?

ANSWER R-4:

The increasing data burden imposed by these sensors has been recognized by the project scientists as a problem requiring special attention. The Office of Space Science and Applications has an Information Systems Office which is sharply focusing interest in this area. Some years ago Office of Aeronautics and Space Technology (OAST) performed systems studies which indicated to us a number of significant technological developments which could contribute to relieving these problems. These technological developments have been addressed in a generic technology program, the NASA End-to-End Data System (NEEDS) program. NEEDS is a technology program which offers significant system enhancements to the processing, distribution, and archiving of these vast amounts of data. It includes: the Information Adaptive System, an Archival Mass Memory, a Modular Data Transport System, a Data Base Management System, and the Massively Parallel Processor. Since NASA has the unique capacity to do this type of generic research as well as maintaining a research staff in place, we feel that OAST should continue doing the research and prototype development. We believe that the current program is sized appropriately.

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QUESTION R-5:

The French SPOT remote sensing satellite system will be using multi-linear array technology. What is the status of your work on multi-linear array sensor technology for remote sensing application?

ANSWER R-5:

The first SPOT mission instrument will have one pan-chromatic and three narrow sensing bands, all in the visible region, a technology area well in hand in the United States. The Office of Aeronautics and Space Technology (OAST) research in multi-spectral linear array (MLA) technology has focused on the 1-4 and 8-12 micrometer infrared bands.

The Office of Aeronautics and Space Technology (OAST) work directly supports the main MLA activity which is managed by the Office of Space Science and Applications (OSSA). Our work focuses on detectors and arrays for the two previously mentioned frequency bands. To date, a 90-element thermal infrared array has been developed and demonstrated, resulting in high quality thermal imagery. A 1000-element array is under development and will be optimized for viewing terrestrial targets.

QUESTION R-6:

How closely do you work with the Space Transportation Systems Office of Advanced Programs in your large space systems technology programs? Is most of your work ground based? Is NASA doing all it can to prepare for future uses of space? What areas of large space systems would you like more emphasis on?

ANSWER R-6:

Close coordination of the Office of Aeronautics and Space Technology (OAST) program with the advanced programs of the Office of Space Transportation System (OSTS) is particularly important because of the relatively large number of technology requirements identified in the studies sponsored by OSTS. We will continue to provide the necessary support as we have done in the past. Our current technology support in the area of large space systems technology is of special importance to the OSTS planning for a possible future permanent presence in space.

NASA has the best technology program that can be recommended within the current economic climate. It does not, however, provide the level of support necessary to conduct system-level technology flight experiments. If and when decisions are made to pursue the development of future large space systems, additional effort could be placed on initiating some technology flight experiments of large structural elements with coupled, distributed sensors and control actuators.

QUESTION R-7:

Will your office be involved in activities to design and acquire a high energy upper stage the DOD recently said it would seek for the late 1980's? Please explain.

ANSWER R-7:

NASA is arranging to participate with DOD in the study of high energy upper stage requirements and specifically will be responsible for defining any non-DOD requirements for such a stage through the 1990's. We believe that, however such a stage would be configured initially, it should be able to evolve gracefully into a high-performance stage for the 1990's. In that context, the Office of Aeronautics and Space Technology (OAST) is developing the technology to enable such evolution into the reusable and space-board upper stages which we forecast may be required in the 1990's. We have programs which will provide the technical base for aero-assisted recovery of a geosynchronous earth orbit returning vehicle; high-performance (Isp > 480 sec.) reusable, continuously throttleable, space maintainable propulsion system; tankage concepts suitable for long-term storage of cryogenic fluids, and compatible with space debris requirements; and storage and transfer of cryogenic fluids in zero-g. By coordinating the planning of a possible future orbital transfer vehicle (OTV) with the potential of emerging technology, an orderly progression of increasing capability for upper-stage vehicles will be possible.

QUESTION R-8:

Could you please comment on the status of your advanced thermal protection work?

ANSWER R-8:

Our advanced thermal protection system research program continues to examine new materials and concepts for future systems. Its main thrust is directed at high temperature, lighter weight, more durable materials. In this coming year, advanced composites will undergo further materials evaluation and thermal exposure ground testing.

Carbon-carbon composites possessing superior damage tolerance will be evaluated for large area high temperature application. High temperature weight efficient metallic composites utilizing the high strength capability of nickel alloys will undergo preliminary fabrication and test. Large flexible ceramic blanket concepts will continue to be evaluated for both temperature and the vibroacoustic response.

QUESTION R-9:

In the Systems Technology Program (RD 10-25) you have eliminated funding for Space Systems Studies and Information Systems Technology. What is the affect of this?

ANSWER R-9:

The Space System Studies line item has been deleted so that there is no longer a sustaining level-of-effort budget element to assess technology planning against perceived future program needs. Clearly, needs will arise to conduct such studies on specific issues. The mechanism for funding will be to utilize R&T Base budget from the most appropriate source(s) at the time such need develops. The Space Systems Technology Model will continue and will serve as a consoli-

SPACE RESEARCH & TECHNOLOGY

R&D BUDGET
($M)

	FY 1981	FY 1982		FY 1983
		BUDGET ESTIMATE	CURRENT ESTIMATE	
R&T BASE	100.4	115.3	105.2	115.6
SYSTEMS TECHNOLOGY	8.2	7.0	2.8	4.4
STANDARDS & PRACTICES	2.1	3.0	3.0	3.0
TOTAL R&D	110.7	125.3	111.0	123.0

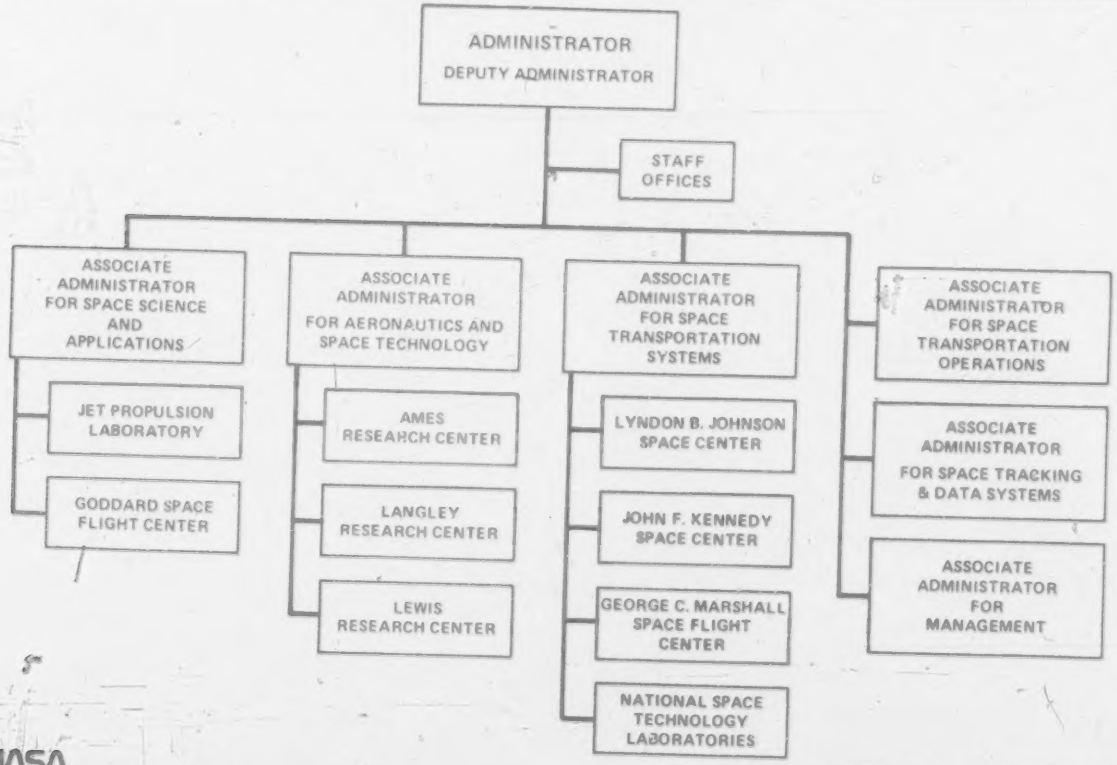
1205

NASA

OAST NASA HQ R82 537(3) 1 25 82

Figure 2

NASA ORGANIZATION


ADMINISTRATOR
DEPUTY ADMINISTRATOR
STAFF OFFICES
ASSOCIATE ADMINISTRATOR FOR SPACE SCIENCE AND APPLICATIONS
JET PROPULSION LABORATORY
GODDARD SPACE FLIGHT CENTER
ASSOCIATE ADMINISTRATOR FOR AERONAUTICS AND SPACE TECHNOLOGY
AMES RESEARCH CENTER
LANGLEY RESEARCH CENTER
LEWIS RESEARCH CENTER
ASSOCIATE ADMINISTRATOR FOR SPACE TRANSPORTATION SYSTEMS
LYNDON B. JOHNSON SPACE CENTER
JOHN F. KENNEDY SPACE CENTER
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL SPACE TECHNOLOGY LABORATORIES
ASSOCIATE ADMINISTRATOR FOR SPACE TRANSPORTATION OPERATIONS
ASSOCIATE ADMINISTRATOR FOR SPACE TRACKING & DATA SYSTEMS
ASSOCIATE ADMINISTRATOR FOR MANAGEMENT

NASA

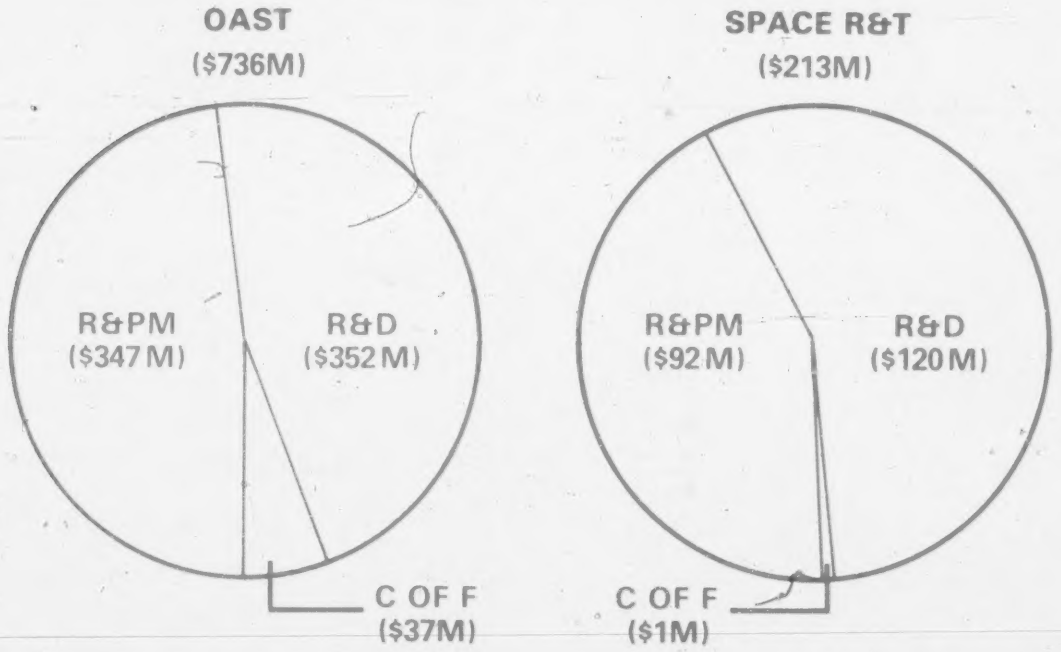
Figure 3

OAST

NASA HQ 82R 512(3)
1-18-82

1206

OAST INSTITUTIONAL AND PROGRAM RESOURCES



NASA

OAST NASA HQ R82 534(3) REV 2 5 82

Figure 4

FUNDING DISTRIBUTION & ROLES

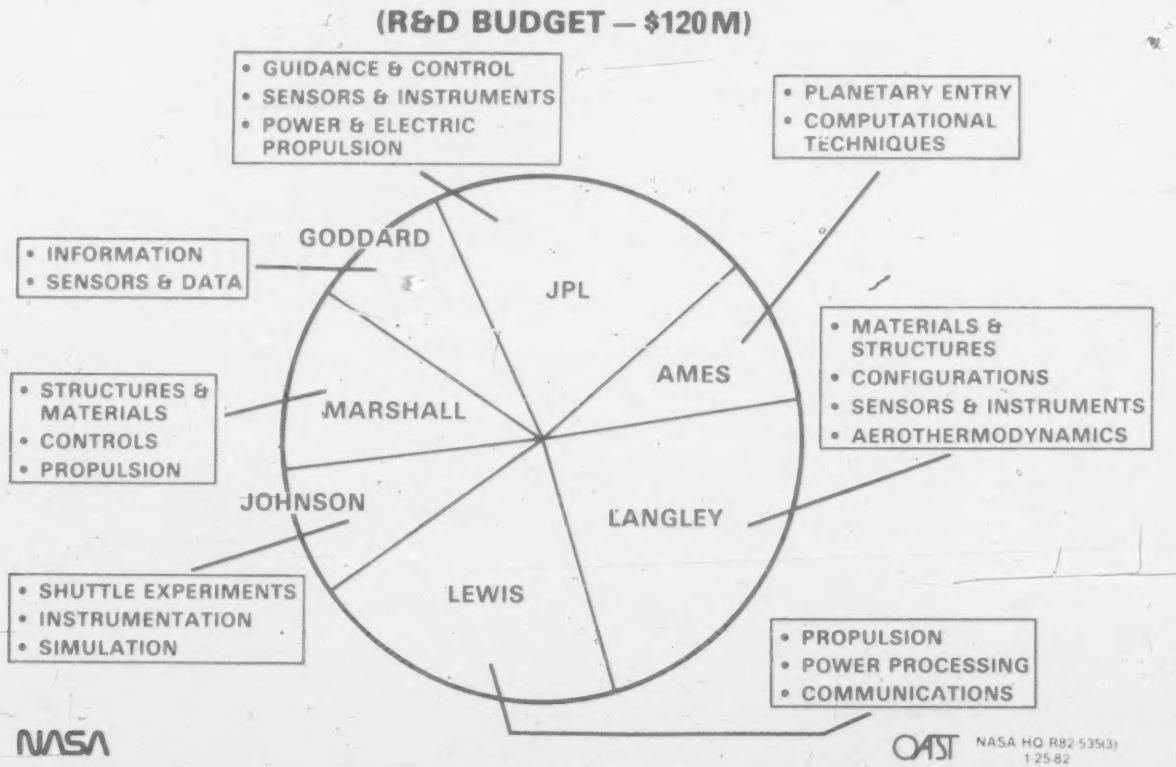
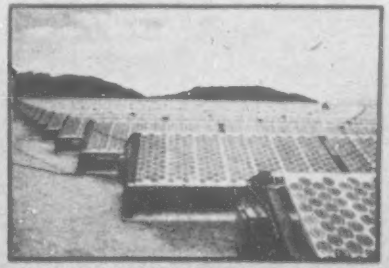


Figure 5

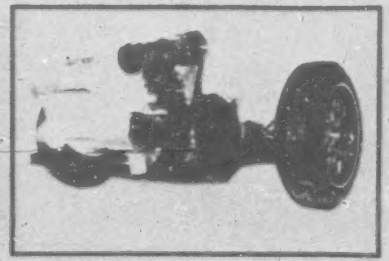
NASA ENERGY TECHNOLOGY

MAJOR REIMBURSABLE PROGRAMS

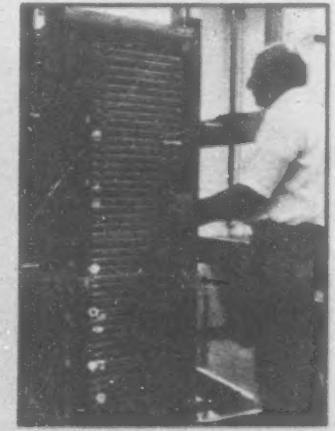
EXPERIMENTAL 2500 KW
WIND TURBINE



60 KW PHOTOVOLTAIC SYSTEM



AUTOMOTIVE GAS TURBINE
GENERAL MOTORS CONCEPT



PHOSPHORIC ACID
FUEL CELL
40 KW VERIFICATION UNIT

NASA

OAST NASA HQ RE82-5140) 1-25-82

Figure 6

dation and efficient focus for filling this planning need. Funding for this activity will be provided within the R&T Base.

The information Systems Technology line item served to provide additional advanced technology support for the satellite communications activities in the Office of Space Science and Applications. However, critical generic technology elements in support of 30/20 GHz systems and narrow-band applications will be accommodated within the R&T Base.

QUESTION R-10:

Did NASA request funds for energy R&D? What areas of your research have applications to help solve terrestrial energy problems?

ANSWER R-10:

NASA did not request funds for energy R&D in FY 1983.

At the Lewis Research Center (LeRC) and the Jet Propulsion Laboratory (JPL), there are many traditional areas of research that have applications to help solve terrestrial energy problems. Examples are: ground propulsion systems, turbomachinery aerodynamcis, high temperature materials, rotating machinery disciplines, engine controls, stationary power systems, electrochemistry disciplines, solar cell and solar thermal technology development, fossil energy systems, sensors, controls and automation.

QUESTION R-11:

What is the status of the NASA End-to-End Data System (NEEDS) software program (for remote sensing)?

ANSWER R-11:

Computer software programs both support and are an integral part of the NASA End-to-End Data Systems (NEEDS) program. Although NEEDS is primarily a hardware program that offers significant improvements to the processing, distribution and archiving of these data over conventional systems, the NEEDS program also has significant software requirements. Individual software elements are necessary to drive the hardware in the system configuration. Some of these elements are the software that drive the information adaptive system and the massively parallel processor. Several elements of the NEEDS program are primarily software. These elements include the interactive verification and test, a program that verifies and tests flight software for errors, and the data base management system, a software system that interfaces the archival mass memory hardware system with users. The NEEDS program is funded at a level adequate to maintain the research elements of this program at appropriate levels.

Mr. FLIPPO. Thank you, Doctor. I certainly did not intend to push you on that very important area in energy.

We have a vote on the floor and we will have to go soon but there are two very important areas, I think. Your budget received a significant reduction. This morning's Washington Post reports an article about the Soviets being ready to orbit laser weapons. Are you familiar with the article?

Dr. KERREBROCK. Yes; I am.

Mr. FLIPPO. The article suggests that the Soviets intend to or are likely to place lasers in space, possibly as early as next year. Are you doing any work in the technologies that would be needed to accomplish something like that, that you can tell us about, or any of the supporting technologies?

Dr. KERREBROCK. The NASA involvement in those technologies is very small. It runs about $1 million a year. As you know, the great majority——

Mr. FLIPPO. Is that your capacity?

Dr. KERREBROCK. No, sir.

Mr. FLIPPO. You have greater capacity than that?

Dr. KERREBROCK. Yes, sir. There has been a difference in emphasis, in addition to the disparity in funding levels between the DOD, which has the largest program, of course, and NASA in that the DOD program has been focused on pulsed lasers for weapons purposes. The very small NASA program that we have has been focused on continuously operating lasers for energy transmission in space, at lower power levels but continuously. One of the achievements of that program which happened quite recently was the first operation of a solar pump laser at Langley Research Center. It happened last year.

We could, of course, within our technological capability, do much more in this area if it were deemed advisable.

Mr. FLIPPO. Could you tell us what area of your budget you felt was most severely impacted by budget constraints, or the other way of looking at it, what would be your priorities for projects you would like to accomplish?

Dr. KERREBROCK. As I indicated, the largest reductions that we say this year were in the space systems technology areas where we attempt to transition the basic work toward the using programs. It is a very minimal level of effort now. We have essentially just a base R. & T. program and we do feel that more activity in that area would be very helpful. However, still the highest priority, as I indicated, is attached to the base R. & T.

Mr. FLIPPO. Doctor, thank you very much for your testimony. We are going to have to go vote, and come back and receive Bob's testimony following that. Thank you very much. We would like to submit some questions to you for the record.

Dr. KERREBROCK. Very good.

Mr. FLIPPO. Thank you. The committee stands in recess.

[Recess taken.]

Mr. FLIPPO. Mr. Allnutt, we are delighted to have you with us today. Please proceed as you deem appropriate.

STATEMENT OF ROBERT F. ALLNUTT, ACTING ASSOCIATE ADMINISTRATOR, OFFICE OF EXTERNAL RELATIONS, NASA, ACCOMPANIED BY RONALD J. PHILIPS, DIRECTOR, TECHNOLOGY UTILIZATION AND INDUSTRY AFFAIRS DIVISION, NASA

Mr. ALLNUTT. Thank you, Mr. Chairman.

Ron Philips and I both have very short statements and, with your permission, we will summarize those because I know it is a busy afternoon on the floor.

I want to first of all just thank you for this opportunity and to say that, as Jim Beggs testified earlier before the subcommittee, we have gone through a major reorganization within headquarters. As part of that organization, the technology utilization program was moved into the External Affairs Office which, as you know, I am temporarily heading. We have done some internal restructuring and taken what had been the Division of Government and Industry Affairs and formed a new division called Technology Utilization and Industry Affairs. Ron Philips, who, in an earlier incarnation, was in charge of technology utilization in the sixties, is now in charge of this new division. He will give our principal testimony.

Our hope is that by putting technology utilization together with the other parts of external affairs, we can really create a synergistic effect and get both more visibility for the program—although it has high visibility in the public now—and also get some elements of external affairs working together with that program to better effect for all concerned. For fiscal year 1983 the budget request technology utilization is $4 million. This is a reduction of the resources compared to fiscal year 1981 and fiscal year 1982. However, we are planning to maintain an effective response to the requirements of the National Aeronautics and Space Act of 1958, as it has been amended from time to time over the years. We are committed to continuing new techology identification, publication, and dissemination activities as well as the very effective bioengineering applications program.

The technology utilization program has been strongly supported by this subcommittee, year in and year out, for nearly 20 years. As you know, it has developed in concert with the private sector, filling gaps in the innovation process necessary to make the process work effectively and efficiently.

Literally thousands of transfers of aerospace technology have occurred. These have ranged from simple, everyday consumer products to major systems that have contributed to solving some of society's most pressing problems, a record of which NASA and this subcommittee can be proud.

Mr. Chairman, we are committed to continue and maintain an aggressive and effective effort in technology utilization, within the resources and manpower available in the bill before you. I would like to ask Ron to testify in somewhat more detail about the request, and then we will be happy to answer your questions.

Mr. FLIPPO. Very good. Thank you. We are pleased to have you with the commitee.

Mr. ALLNUTT. Thank you.

[The prepared statement of Mr. Allnutt follows:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
March 3, 1982

Statement of
Robert F. Allnutt
Acting Associate Administrator
for External Relations

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

Thank you for this opportunity to discuss the NASA Technology Utilization Program and to present the proposed program and supporting budget request for Fiscal Year 1983.

As Mr. Beggs has testified before this Subcommittee, a major reorganization was recently completed in NASA Headquarters. One aspect of this reorganization was to place responsibility for Technology Utilization within the Office of External Relations. There we have combined it with the previous Division of Government and Industry Affairs, forming the new Division of Technology Utilization and Industry Affairs. We have named Ron Philips, who was in charge of Technology Utilization for NASA in the late sixties, the Director of this new Division. During the seventies, Ron was Senior Vice President of Public Technology Inc., a private sector organization concerned with use of new technology by state and local governments.

This realignment will be particularly important to the Technology Utilization program for several reasons. First, it recognizes that Technology Utilization is a NASA-wide program requiring broad interactions with all program offices and field centers. Second, the level of program visibility will be measurably heightened both internally as well as externally to the Agency. And finally, we anticipate that considerable synergism will be possible through the close coupling of technology utilization with the industry affairs functions for which Ron Philips was already responsible, including the American Institute of Aeronautics and Astronautics "Fortune 500" program and the similar small business center visits, efforts pioneered by Ron's office.

For FY 1983, the NASA budget request for Technology Utilization is $4.0 million. We recognize that this request represents a reduction in program resources compared to the FY 1982 operating level. However, we plan to minimize the impact on program elements while maintaining an effective response to the requirements of Section 305(b), 203(a) and 102(f) of the National Aeronautics and Space Act of 1958. NASA will continue its new technology identification, publication and dissemination activities designed to

encourage public and private sector use of new technological advances resulting from its R&D programs. And we will continue to support the successful bioengineering applications program. We will rely more heavily on funding support by participating user agencies in our public sector applications work.

The NASA Technology Utilization Program as it is structured today has resulted from experimental programs and practical evolution strongly supported year-in and year-out by this Subcommittee and its predecessors for nearly 20 years. It has developed in concert with the private sector, filling gaps in the innovation process as necessary to make the process work effectively and rapidly.

Literally thousands of transfers of aerospace technology have occurred in which private firms have profited through involvement with the program. These have ranged from simple everyday consumer products to major systems that have contributed to solving some of society's pressing problems -- a record for which NASA is justifiably proud.

Mr. Chairman, the NASA Technology Utilization Program has had a long and productive history in the Agency and has accomplished a great deal in the transfer of aerospace-developed technology for use in the public and private sectors of the economy. We are committed to continue and maintain an aggressive and effective effort in technology utilization within the resources and manpower available in the Bill before you.

Now I would like to ask Ron Philips to discuss the budget plan in somewhat more detail and to describe some of our recent program accomplishments. Then we will be pleased to respond to your questions.

# # # #

Mr. FLIPPO. Mr. Philips.

Mr. PHILIPS. Mr. Chairman, I do have a longer statement which, with your permission, I will submit for the record.

Mr. FLIPPO. Without objection.

Mr. PHILIPS. I will summarize that.

I am pleased to be testifying before you as Director of the Technolog, Utilization TU and Industry Affairs Division. I have had an association with the TU program both inside and outside Government for over 14 years. I have seen the enthusiasm with which the program has been accepted by industry and users alike. I am confident that we can conduct a tight and effective program which contributes to the national efforts to use advanced technology for improving the Nation's productivity and econmic competitiveness.

As Bob Allnutt indicated, our budget for fiscal year 1983 is $4 million. The major program activities for fiscal year 1983 are in the dissemination and applications areas. Under technology dissemination we are requesting $1 million to continue publication and packaging of data such as the NASA "Tech Brief" journal and technical support packages, and $2.2 million for support of our university operated dissemintion centers. It is through these centers that aerospace technical information, computer programs, and assistance are made available to industry and the public sector. We will reduce the program evaluation and support activity to a minimal amount.

The technology applications part of the program requires $800,000. This will allow one applications team to continue problem identification at a reduced level, continue feasibiliity analyses, and high-priority applications project completion.

Technology dissemination continued to flourish during the past year, commanding increased visibility and participation in the U.S. industrial sector. For example, NASA "Tech Briefs," our principle new technology announcement mechanism, enjoyed a continued high level of interest as evidence by a peak year with 75,000 subscribers.

In addition, nearly 160,000 inquiries were received last year from industrial scientists, engineers, and businessmen for additional technical information announced in Tech Briefs. NASA also continued to provide industry with technology search and assistance service through the NASA-sponsored network of dissemination centers. Another peak year was reached last year when total industrial income for all NASA dissemination center activities topped $4 million, a 22-percent increase over the previous year. The continuing decline in industrial productivity is of grave national concern. The role of technology and its impact on productivity is increasingly clear. Westinghouse, for example, estimates—and I have no reason to dispute this—that the major contributors to productivity improvement are capital, 25 percent; labor, 15 percent; and technology, 60 percent.

I am pleased to have this opportunity to tell you of an ongoing productivity program and to report to you the progress that we have made to date. I believe you heard some of this yesterday afternoon from Dr. Millar of Deere & Co. but I would like to give you a little fuller explanation of what we are doing. In late 1980, NASA entered into an unfunded agreement with the AIAA to act

as an industrial interface or broker, to introduce nonaerospace firms to NASA and its technologists, and to research and development activities at NASA field centers. We have just conducted our 12th industry executive seminar at Ames Research Center. Our next seminar is scheduled in mid-March at the Jet Propulsion Laboratory in Pasadena, Calif. Over 250 R. & D. executives and senior technical managers of 126 corporations have attended these hands-on seminars to date. The seminars have afforded industry the environment and the interpersonal contact essential to the development of follow-on relationships between industry and NASA technologists. It has resulted in technical exchange agreements between NASA and Deere & Co., International Nickel, and Du Pont. Three additional agreements are in preparation. Another important indication of success is the postseminar volume of contracts initiated by industry with field center scientists and engineers requesting meetings, additional information, or discussion on specific industrial adaptations or applications of NASA technology.

Technology applications is another important element in the TU program and its applications engineering effort involves the use of NASA expertise to redesign and reengineer existing aerospace technology for solution of problems encountered by other Federal agencies or other public sector instititions. Such efforts span public need in bioengineering, transportation, environmental monitoring, public safety, and rehabilitation for the disabled and handicapped. Significant progress and results have been achieved over the past several years in the adaptation and use of aerospace technology in these areas of human concern.

The significance of the problem, whether it be Federal, State, local government agency, the private sector, or a university, and their willingness to finance a significant share of the transfer, determines to a considerable extent which project we will develop. It should be noted that we work closely with the user from the project definition stage through development and demonstration of concept but require the user to staff and fund field test or clinical investigation. This method allows us to effectively and rapidly transfer aerospace technology and concepts. During 1981, we completed 22 applications projects and two preengineering studies. In fiscal year 1982, our emphasis will be to complete on schedule those projects maintaining major user support and conduct preengineering studies as opportunities are identified and assessed.

In conclusion, Mr. Chairman, as noted earlier, the budget request for fiscal year 1983 is $4 million. While this constitutes a reduced program level, we feel confident that an effective and cost-efficient program can be maintained. Moderate funding levels in the past have created a cost-conscious approach to the program and have necessitated careful analysis of program options in pursuit of TU objectives. We are proud of this record and are firmly committed to carry on in this tradition.

Thank you.

[The prepared statement, plus answers to questions asked of Mr. Philips, follows:]

Hold for Release Until
Presented by Witness
March 3, 1982

Statement of
Mr. Ronald J. Philips
Director, Technology Utilization and Industry Affairs
Office of External Relations

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
United States House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am very pleased to be testifying before you as Director of the Technology Utilization and Industry Affairs Division. I have had an association with the Technology Utilization Program both inside and outside the government for over fourteen years. I have seen the enthusiasm with which the Program has been accepted by industry and users alike. I am confident that we can conduct a tight and effective program which contributes to the national efforts to use advanced technology for improving the nation's productivity and economic competitiveness.

We have taken steps in putting together the FY 1982 operating plan to stabilize TU program operations, particularly in our technology dissemination area of activity. The public sector applications work, including applications teams and projects, has been phased down to a level which permits some continued interactions with public sector organizations as well as project definition efforts including problem identification, technology matching and phase zero feasibility activities. Under the current program, we are committed to the completion of selected high priority projects which will have a significant and substantial impact in the public health and safety areas.

As Bob Allnutt indicated, our budget for FY 1983 is $4 million. The major program activities for FY 1983 are Technology Dissemination and Technology Applications.

Under Technology Dissemination we reques $1.0 million to continue publication and packaging of data, such as the NASA Tech Brief journal and technical support packages, and $2.2 million for support of our university-operated dissemination centers. It is through these centers that aerospace technical information, computer programs and assistance is made available to industry and the public sector. We will reduce the program evaluation and support activity to a minimal amount.

The Technology Applications part of the Program requires $800 thousand. This will allow one applications team at a reduced level to continue problem identification and feasibility analyses and high priority applications project completion.

TECHNOLOGY DISSEMINATION - $3.2 million

PUBLICATIONS - ($1 million)

The TU publication and dissemination programs continued to flourish during the past year, commanding increased visibility and participation in the U.S. industrial sector. For example, NASA Tech Briefs, our principle new technology announcement mechanism, enjoyed a continued high level of interest as evidenced by a peak year with 75,000 subscribers. In addition, nearly 160,000 inquiries were received last year from industrial scientists, engineers, and businessmen for additional technical information announced in Tech Briefs.

NASA plans to reexamine its current free distribution policy with the view toward possible conversion of Tech Briefs to paid subscription.

Dissemination Center Network - $2.2 million

In addition, NASA continued to provide U.S. industry with technology search and assistance service through the NASA-sponsored network of dissemination centers. Another peak year was reached last year when total industrial income for all NASA dissemination center activities topped $4 million, a 22 percent increase over the previous year.

Providing U.S. industry with the results of NASA and related research and development results is the principal responsibility of a network of seven NASA

Industrial Applications Centers (IACs) and two State Technology Assistance Centers (STAC). These centers, having pioneered in the delivery of computer-retrievable technical information to industry, constitute a primary link between private industry and technical expertise currently existing within NASA Field Centers and contractor organizations.

The IACs function essentially by providing answers to specific technical questions, through both computer-retrieved information and customized personal inputs from members of the IAC technical staffs and NASA Field Centers. Thousands of large and small firms in manufacturing, services, transportation, communications and many other areas have routinely used the IACs as their primary information service for a broad spectrum of needs from problem solving to document delivery. The use of IAC services has resulted for many firms in the creation of new products or processes and very substantial dollar savings.

Last year, the Goodyear Tire and Rubber Company, the world's largest manufacturer of rubber products, joined with the NASA Industrial Applications Center at the University of Pittsburgh in an attempt to solve a major socioeconomic problem through the cooperative effort of business, education and government. Faced with a substantial decline in volume production to several market segments, principally transportation, Goodyear turned to the NASA IAC for assistance. The Goodyear project is aimed at utilizing aerospace and other government technologies to revitalize Goodyear's partially empty factories and unemployed work force. Such revitalization may be possible through improvements in plant manufacturing processes and/or product diversification.

An eighteen month joint study and evaluation effort with Goodyear is underway including visits to NASA facilities and other government laboratories. A schedule of activities and teams, including University of Pittsburgh faculty, IAC staff members, and Goodyear executives, has been established. The project is seeking to exploit all reasonable sources of available government technologies. These raw ideas will be expanded and clarified by faculty teams, working in conjunction with the NASA IAC, and screened against the technology base and human resources of the Goodyear plants, particularly in St. Mary's, Ohio, where current plant production is less than 50 percent of capacity.

NASA's State Technology Applications Centers (STACs), were established to investigate the viability of decentralizing the functions performed by our

Industrial Applications Centers on a regional basis to the state and local level. This approach utilizes the relationships between state universities and local industry and government to assist in the technology transfer process. There are currently two STACs -- one in Florida and the other in Kentucky. Although both perform computerized literature searching services similar to the IACs, the Florida STAC serves primarily small business and high technology industrial clients, while the Kentucky STAC assists mainly state and local public sector organizations. Both STACs have proven very successful in providing beneficial assistance to their clients. Key to their success has been a strong commitment by their respective state governments, which provide over fifty percent of the requisite funding on a cost-share basis with NASA. Last year, the NASA STACs experienced a client growth rate of approximately 45 percent over the previous year.

Software Dissemination

COSMIC, NASA's Computer Software Management and Information Center, achieved a remarkable 37 percent growth rate in 1981, with total sales climbing to almost three-quarters of a million dollars. The Center performs the job of a sophisticated library or clearinghouse, for computer programs developed by NASA and other government agencies. Upon receiving new programs, COSMIC evaluates them to determine their suitability for public release, performs a computer checkout to ensure they will compile properly, announces their availability to the public, and reproduces and distributes the programs to customers wishing to purchase them. Fees range from $100 t $10,000, depending on the size and complexity of the program, with an average price of about $1,000. The income collected is used to offset most of COSMIC's operating expenses, although NASA contributes approximately $250,000 per year. Included in this amount is funding for maintenance of a very sophisticated software package, as well as "free" distribution of programs to NASA centers and other tasks associated with operation of the facility.

One of these tasks is the identification of applications of the software distributed by COSMIC. Whenever possible COSMIC attempts to obtain an estimate of benefits of using software purchased from them, and often customers estimate savings in the thousands. For example, Illinois Bell Telephone reported an overall savings of 10 percent on new software development costs by using an assembly language program as a programming aid. The Environmental Research Institute of Michigan saved $5-6,000 using an ocean wave crest program in a

coastline mapping study. International Power Technology Inc. used two thermodynamic programs in a program to evaluate regenerative gas turbine engines, with savings of 200 person-hours and $8,000. Magnavox reported savings of six person-months in the development of a digital optical recorder, and Geothermal Services Inc. saved 9-12 person-months using a plotting and contouring program to present drilling data in graphic form for use by their clients in geothermal exploration. Even the Centers for Disease Control were able to use a least-squares data analysis program to analyze data and assist in establishing reference methods that will be used by hospitals across the country.

A more detailed example of how this technology aids industry is the use of a COSMIC program by Philadelphia Gear Corporation. Philadelphia Gear Corporation, King of Prussia, Pennsylvania produces a diverse line of power transmission products, including enclosed gear drives, fluid mixers and variable speed drives. The company specializes in custom units for unique applications, such as Coast Guard ice-breaking ships, steel mill drives, coal crushers, sewage treatment equipment and electricity-generating wind turbines. Philadelphia Gear has recently used two NASA/COSMIC computer programs -- one dealing with shrink fit analysis and the other with rotor dynamics problems -- in computerized design and test work. The COSMIC programs, developed by Lewis Research Center, were used to verify existing in-house programs, in accordance with Philadelphia Gear's practice of insuring design accuracy by checking its company-developed computer methods against the reliable procedures developed by other organizations. See Figure I.

Industrial Productivity

The continuing decline in industrial productivity is of grave national concern. The role of technology and its impact on productivity is becoming increasingly clear. Westinghouse, for example, estimates that major contributors to productivity improvement are capital 25 percent, labor 15 percent and technology 60 percent.

I am pleased to have this opportunity to tell you of an on-going productivity program and to report to you the progress we have made to date.

In late 1980, NASA entered into an unfunded agreement with the American Institute of Aeronautics and Astronautics (AIAA) to act as an industrial interface, or broker, to introduce non-aerospace firms to NASA and its technologists, and to research and development

activities at NASA field centers. We have just conducted our 12th Industry Executive Seminar at Ames Research Center in Sunnyvale, California. Our next seminar is scheduled in mid-March at the Jet Propulsion Laboratory in Pasadena, California.

Over 250 R&D executives and senior technical managers of 126 corporations have attended these hands-on seminars to date. These seminars afford industry the environment and interpersonal contact essential to the development of follow-on relationships between industry and NASA technologists. It has resulted in technical exchange agreements between NASA and Deere and Company, International Nickel, and Dupont. Three additional agreements are in preparation. Another important indication of success is the post-seminar volume of contacts initiated by industry with field center scientists and engineers requesting meetings, additional information or discussions on specific industrial adaptations or applications of NASA technology.

The seminar program has led us into a supporting activity, again with the American Institute of Aeronautics and Astronautics. The AIAA, under contract to NASA, has recently established a program where personnel familiar with NASA field center activities, as well as the technology transfer process, function to expeditiously couple the interests of a specific company with appropriate NASA expertise. This activity is now in its eighth month. Nonaerospace companies such as Deere, A.E. Staley, Eaton, Sohio and Inco are actively involved. This activity is expanding and we intend to continue beyond this initial year's effort. I am pleased to report that industry pays for services provided while NASA funds AIAA for program management functions. We now plan to extend the program to the next smaller tier of nonaerospace companies and to conduct seminars on selected technologies for target audiences.

TECHNOLOGY APPLICATIONS - $800 thousand

Another important element in the Technology Utilization Program is the process of adapting aerospace technology to significant public sector problems through hands-on technology assistance. The significance of the problem, whether it be federal, state or local government agency, the private sector or a university or institution and their willingness to finance a great share of the transfer determines which project we will develop. It should be noted that we work closely with the user from the project definition stage through development and demonstration of concept; but require

the user to staff and fund field test or clinical investigation. This method allows us to effectively and rapidly transfer aerospace technology and concepts.

During 1981 we completed twenty-two applications projects and two pre-engineering studies. In fiscal year 1982 our emphasis will be to complete on schedule those projects maintaining major user support and conduct pre-engineering studies as opportunities are identified and assessed.

Let me now review some of the recent highlights and accomplishments in our applications area to provide a better understanding of our work done in cooperation with other user agencies. See Figure II.

Public Safety

The NASA Technology Utilization Program for the past decade has included many specific projects and programs in public safety. Completed or ongoing applications projects in the field of public safety, include improved lightweight materials for firefighters clothing and equipment, lightweight efficient pumps for portable firefighting pump modules, improved fast response sensors for detection of methane, ethane, and propane in liquified natural gas transfer operations, improved firefighter's radio communications components, slow scan telecommunication and data compression systems for traffic monitoring. See Figures III and IV.

User agencies include the United States Fire Administration, United States Coast Guard, Federal Aviation Administration, Federal Railroad Administration, U.S. Navy Office of Salvage and Repair, U.S. Air Force, and the National Institute of Occupational Safety and Health.

Manufacturing Applications

In manufacturing applications, one completed project is the NASA Ultrasonic Bolt Tension Monitor. The ultrasonic bolt monitor was developed to solve an important problem encountered in nearly all sectors of government and industry. Bolt tightening seems to be a simple and routine matter -- however, it can be a very important process in cases where bolts are subjected to severe stresses and strains; for example, in such structures as pressure vessels, bridges or power plants. Over-tightened or undertightened bolts can fail and cause serious accidents or costly equipment breakdowns. The NASA Bolt Tension Monitor, in simple terms, is an ultrasonic system which measures the stress that occurs when a bolt becomes elongated in the

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process of tightening. Throughout the tightening process, the highly sensitive monitor measures the effective changes in resonance due to elongation of the bolt and changes in the velocity of sound due to strain. The results are translated into a digital reading of the real stress on the bolt, and serves as a guide to proper fastening. In one application, the Bureau of Mines needed to know the tension in the long roof bolts used in mines. The application of ultrasonic technology to improve mine safety has been successfully completed and the Bureau of Mines is now field testing the instrument. Uses of the NASA Bolt Tension Monitor are now finding broader application in a number of industrial manufacturing fields. In recognition of the merit of this work this instrument was nominated for and won an Industrial Research I.R. - 100 Award in 1981. See Figure V.

In another case, the Canadian National Research Council needed to join pipes in a nuclear power plant. NASA's Langley Research Center developed explosive joining techniques which were demonstrated to members of the Canadian National Research Council and the Foster Wheeler Corporation, their U.S. contractor. Later sample materials were provided by the contractor and successfully joined by NASA engineers. After testing of these samples the Canadian National Research Council stated that this technique would be used for their pipe repairs.

In a final example, NASA/JPL has been working on robotics developments for the lunar and Mars lander projects since 1972-73. One of our application teams seeing the results of this work arranged for industrial representatives to visit JPL and view the technology. As a result of these meetings, NASA's JPL and Unimation, Inc. have entered into a three-year cooperative project to equip an industrial robot with sensing capability.

In this project, JPL is adapting and testing various sensor designs. The best design will be integrated into a robot for industrial demonstration and field trials. Unimation is providing the industrial robot, engineering consultation and obtaining measurements of parameters important for sensor design. In addition, Unimation will develop the appropriate software and controls required by a sensing robot and then carry out appropriate field trials and demonstrations. After completion of the work, Unimation has agreed to participate with NASA in a workshop designed to bring these developments to the attention of other American robot manufacturers. See Figure VI.

Rehabilitation

In response to the recognized national need for the application of technology to the needs of the handicapped, NASA has for several years conducted a special program in the rehabilitation area. The basis of our involvement in these areas lies in the National Space Act of 1958 and amendment (Conference Report 95-1509, August 17, 1978). In addition, Public Law 95-602 "Amendments to the Rehabilitation Act of 1973" identifies additional specific areas of cooperation between NASA and the National Institute of Handicapped Research (NIHR).

As one example of this cooperation, the NASA Langley Research Center is working with NIHR's Rehabilitation Engineering Center at the University of Virginia on advanced wheelchairs. Langley is making available and transferring aerospace know-how in the use of computer design, testing and evaluation and in materials selection (e.g., composites). The University of Virginia is using this knowledge in the design and construction of advanced wheelchairs. One early result of this collaboration is a proposed wheelchair for use in commercial aircraft. After extensive testing by several airlines this aircraft chair design has been selected by United Airlines for its use in newly purchased aircraft. We have been told that several manufacturers are interested in the manufacture of this design. See Figure VII.

Another example is the Lunar Hand Controller. At the request of the Veterans Administration Prosthetic Center, NASA/JSC has been cooperating in a project to adapt the lunar vehicle hand controller for use by the handicapped. Nelson and Johnson Engineering Company of Boulder, Colorado was selected by NASA and the VA as the prime contractor. As a result of design studies and mockups based on the selected designs, prototype hardware was ordered, delivered and assembled. The prototype controller was installed in a van and preliminary tests produced excellent results. The lunar hand controller being electronic, can be fine-tuned to adapt to the characteristics of the handicapped individual.

In another project, certain severely handicapped individuals, such as quadriplegics, are unable to perspire or shiver in response to hot or cold environments due to a loss of body thermal regulation. This not only causes discomfort, but also makes these people susceptible to hyper or hypothermia. Based on spacesuit technology, NASA designed a vest-type cooling garment "cool vest" which is being used under medical

supervision by two quadriplegics. Reports to date are that these individuals' comfort has been improved by use of these vests. For possible widespread use and commercialization, the "cool vest" requires clinical test and evaluation. Upon NIHR recommendation we have contacted the Texas Institute of Rehabilitation Research (TIRR) and they agreed to conduct the appropriate clinical tests and evaluations and to participate in the commercialization of this vest. As our part of the project, NASA Ames delivered nine vests to TIRR late last year.

Environment

Another program is designed to enhance environmental quality through application of existing space technology in environmental monitoring and remote sensing. Space technologies employed in the transfer process include: laser absorption, X-ray, microwave, neutron gamma ray and mass spectrometers; multispectral imaging, laser doppler, and proton-induced X-ray emission techniques; and, sonic and microwave communication. A few examples of projects in this area describe our efforts.

A TU applications project to assess the nature and extent of air pollution has been developed with the EPA, California Air Resource Board, and the Southern California Air Quality District. In this case, real time monitoring of ozone, ammonia, and ethylene are needed in connection with smog production. Laser absorption spectrometry and laser long-path monitoring techniques from Spacelab global monitoring technology and microwave spectrometry from Nimbus are being applied and demonstrated at the Haagen Smit Laboratory of the California Air Resource Board in El Monte, California. Resultant measurements of meteorological properties and pollutant concentrations will permit models to be formulated to better understand and predict smog production.

In the area of biological sewage treatment, NASA research during the past ten years has led to the development of a simplified natural process which represents a major technological breakthrough in wastewater treatment and water recycling. In this regard, we have completed a project with the EPA, the Mississippi Departments of Water Pollution Control and Health; and, the Litton Industries Corp. The system, which is odor free and costs less than half as much as a conventional system to operate and maintain, has been approved by the EPA for treating municipal sewage. It combines septic tanks and trickling filters with space-age technology in anaerobic filter and vascular

aquatic plant waste water treatment. This system was presented to the public in March, 1981 and has already been used by an engineering firm for designing two waste water treatment plants, located in Minden and Tallulah, La. The Minden plant will have a capacity of 3.5 million gallons per day and the Tallulah plant 1.4 million gallons per day.

Bioengineering

Working with the medical community, National Institutes of Health, the Food and Drug Administration and industry, NASA is also making significant progress in transferring space technology to develop devices and techniques to improve the quality of life of those with medical disorders.

In the following examples, I will describe two of our current efforts in this area. Today many people are familiar with cardiac defibrillators -- the twin "paddles" emergency medical personnel apply to the chest of those who are suffering a heart attack. Not widely known is the fact that some 10 percent of those who survive a first heart attack subsequently die within a year from a second attack, frequently because they are not defibrillated soon enough. NASA, in cooperation with the Johns Hopkins Applied Physics Laboratory (APL), Dr. Michel Mirowski of Sinai Hospital in Baltimore, and Intec Systems, Inc. has collaberated in the development of an automatic, implantable defibrillator (AID). When AID, which is implanted under the skin and has electrodes connecting it to the heart, detects cardiac arrhythmia, known as "ventricular fibrillation," it automatically supplies an electrical defibrillation shock directly to the heart at less than 10 percent of that required by the external "paddles." AID is intended only for those persons who have survived a previous heart attack and who are judged to be high risk candidates for a second attack. To date, about 50 of these devices have been impanted. An external recorder also accompanies each patient to store information on heart activity prior to defibrillation -- similar to a flight recorder on an airplane. So far these implanted units have initiated about 40 life-saving defibrillations.

Under sponsorship of the Goddard Technology Utilization Office work is underway at APL to develop an improved version of the AID, which will be more versatile, treat different arrhythmias in addition to ventricular fibrillation, remove the need for the external recorder, and remove the need to operate on the patient in order to adjust the parameters of the detection and treatment programs stored in the electronics inside the implanted device. See Figure VIII.

Another example is a Programmable Implantable Medication System (or PIMS) -- a microminiaturized, computer-directed system for delivery of medication to target organs, in precisely controlled amounts, on individually determined schedules, from a source within the patient's body.

Millions of persons suffer from diseases such as diabetes, hypertension, mental illness, epilepsy and intractable pain which can be treated with various medications. Incomplete patient compliance, whether accidental or deliberate, can result in overdose or under-medication, causing possible serious effects. Further, some medications are commercially available in such small amounts that they must be administered as near the target organ within the body as possible. Others have multiple, widespread effects -- both of which can be better used if administered in small amounts near the intended target. Moreover, PIMS will deliver the medication in amounts and on a schedule determined for optimal clinical results, without requiring repeated action by the patient.

Digital circuitry similar to that of the proposed MAGSAT satellite was used in the design of the electronics inside the implantable part of PIMS. The communications link between the implanted device and the attending physician is based on Goddard Space Flight Center and Applied Physics Lab's experience in designing small satellites.

Companies involved are: Novo Research Institute of Copenhagen which develops a special concentrated insulin; Wilson Greatbatch, Inc. and GTE which are developing the batteries; Parker Hannifin for the development of fluid handling systems; and Pacesetter, Inc., producer of the integrated commercial device.

Initial production units for clinical evaluation will be tested by Dr. Richard Sherins at the National Institute for Child Health and Human Development (NIH) and by Dr. Christopher Saudek, of Johns Hopkins, who is funded by the National Institute of Arthritis, Metabolic and Digestive Diseases (NIH). See Figure IX.

Incidentally, we are pleased to report that as a result of work on the PIMS project, Parker Hannifin, a world leader in fluid systems, has developed a Biomedical Products Division. On its own, Parker Hannifin is now taking its technology from aircraft and space systems to develop products for medical use. Their initial efforts are directed toward medical disorders like diabetes, arthritis, incontinence and colostomies.

Applications Teams

NASA contractor Applications Teams will continue to link the user community with NASA scientists and engineers by acting as a link between the user community, federal agencies, institutions, manufacturers, and industrial organizations. The teams themselves are interdisciplinary and frequently operate as a task team, offering a matrix of scientists, engineers, technologists and market experts to assist in the brokerage process. The principal responsibilities of these teams are (1) to identify and interpret national trends and technology-related problems; (2) to identify potential opportunities to solve these problems with aerospace technology; (3) to work with NASA to screen for the best candidate; and, (4) to assist in the risk assessment, commercialization strategy and identification of potential manufacturers, when appropriate.

These teams are a necessary part of our system to expedite the transfer of technology by linking public sector users, industry and NASA together to achieve optimum and meaningful results.

SUMMARY

In conclusion, Mr. Chairman, as noted earlier, the Technology Utilization budget request for FY 1983 is $4.0 million. While this constitutes an austere program level, we feel confident that an effective and cost-efficient program can be maintained. Moderate funding levels in the past have created a cost-conscious approach to the program and have necessitated careful analysis of program options in pursuit of technology utilization objectives. We are proud of this record and are firmly committed to carry on this tradition.

GEAR DRIVE TESTING

- PHILADELPHIA GEAR CORP. INSURES GEAR DESIGN ACCURACY VIA COMPUTER.
- NASA-DEVELOPED COMPUTER PROGRAMS ON SHRINK FIT ANALYSIS AND ROTOR DYNAMICS AIDED COMPANY DESIGN AND TEST EFFORTS.
- EXAMPLE OF NASA-COSMIC DISSEMINATION PROGRAM APPLIED TO LARGE ROLLING MILL GEARING.

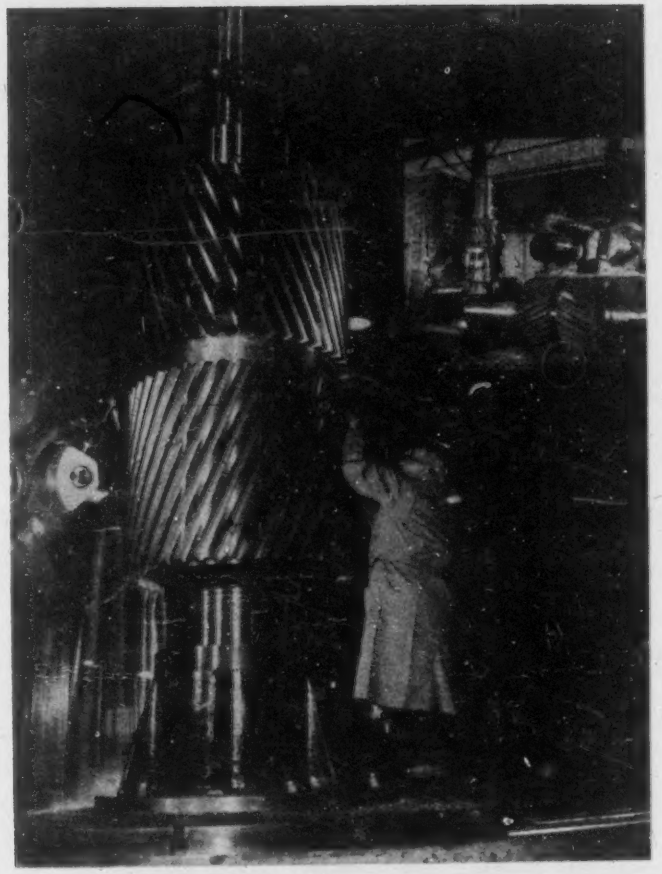

FIGURE 1

TECHNOLOGY APPLICATIONS OBJECTIVE:
TO PROMOTE THE SECONDARY APPLICATION OF AEROSPACE TECHNOLOGY BY COOPERATIVELY BUILDING AND TESTING PROTOTYPE HARDWARE

FIGURE 2

PROJECT FIRES
FIREFIGHTERS PROTECTION ENSEMBLE

- JOINTLY SPONSORED BY U.S. FIRE ADMINISTRATION, NASA
- JACKET AND TROUSERS PBI GORETEX VAPOR BARRIER
- BOOTS -
  - NEOPRENE
  - STEEL SOLE PROTECTION
- GLOVES -
  - NOMEX/KEVLAR
- HELMET -
  - FIBERGLASS COMPOSITE
  - POLYURETHANE IMPACT CAP
  - FACE-EYE PROTECTOR
- USFA TO TEST IN 14 U.S. CITIES

FIGURE 3

QUESTIONS FOR MR. RONALD J. PHILIPS FROM THE HEARING ON MARCH 3, 1982, BEFORE THE HOUSE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS (CONGRESSMAN FLIPPO)

QUESTION 1:

You talk about the importance of stabilizing the Technology Utilization program, yet your FY 1983 funding is half that for FY 1982. Will funding fluctuations on the order of 50 percent help stabilize the Technology Utilization program?

ANSWER 1:

NASA intends to accomplish the stabilization of the Technology Utilization program by utilizing the greater part of the FY 1983 request for technology dissemination activities. Approximately the same level of awareness of NASA technology with industry and potential users will be maintained through our major publication, NASA Tech Briefs, and the activities of our dissemination centers.

The remainder of the FY 1983 request will be used for the applications engineering program in the biomedical field. Stabilization of these activities will be accomplished by completing high priority biomedical projects and by maintaining a biomedical applications team in support of selected feasibility studies in cooperation with NIH and other public sector medical organizations. We are hopeful that the NASA funds will be supplemented with funds from users.

QUESTION 2:

The Technology Utilization program for FY 1983 funding compared to FY 1982 funding is as follows:

Technology dissemination - 120 percent increase
Technology applications - 20 percent decrease
Program Evaluation & Support - cancelled
Civil Systems - cancelled

What should we infer from these changes? Have you changed the Technology Utilization program objectives?

ANSWER 2:

The Technology Utilization program objectives have not changed. For FY 1983, we are requesting $4 million for Technology Utilization to continue the transfer of NASA-developed technology to U.S. industry, the public and other Government agencies. This represents a significant reduction from the current FY 1982 level of $8 million. While our primary focus will be on the continuation of active publication and technology dissemination activities, we will increase our efforts to acquire larger user contributions from both the private and public sectors. For example, we plan to continue feasibility and planning efforts in technology applications to define public sector applications projects in conjunction with other mission-oriented Federal agencies, with the view toward shifting budgetary responsibility for resultant projects to those user agencies. In addition, we will study the possibility of converting NASA Tech Briefs and other publications to paid subscription.

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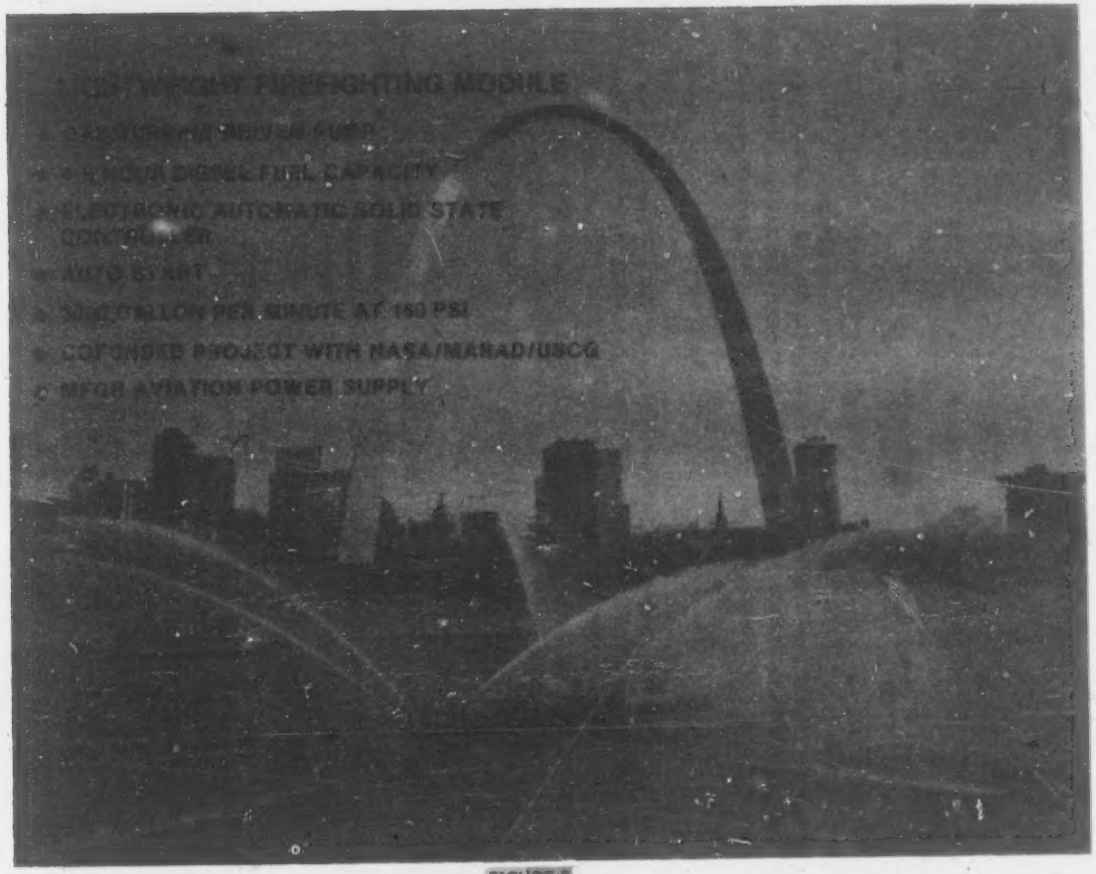

LIGHTWEIGHT FIREFIGHTING MODULE
ELECTRONIC AUTOMATIC SOLID STATE
AUTO START
COFUNDED PROJECT WITH NASA/MARAD/USCG
MFGR AVIATION POWER SUPPLY

FIGURE 8

ULTRASONIC TORQUE WRENCH

- NASA/LaRC RESEARCHER DESIGNS ULTRASONIC TORQUE WRENCH
- NASA/BU-MINES ENTER INTO COOPERATIVE AGREEMENT TO DEMONSTRATE WRENCH
- TORQUE WRENCH TESTED ON MINE ROOF BOLTS IN MINE ENVIRONMENT
- TORQUE WRENCH DEMONSTRATES ABILITY OF DETECTING STRESS IN ROCK
- WINS I.R.-100 COMPETITION
- BU-MINES FIELD TESTING IN 82

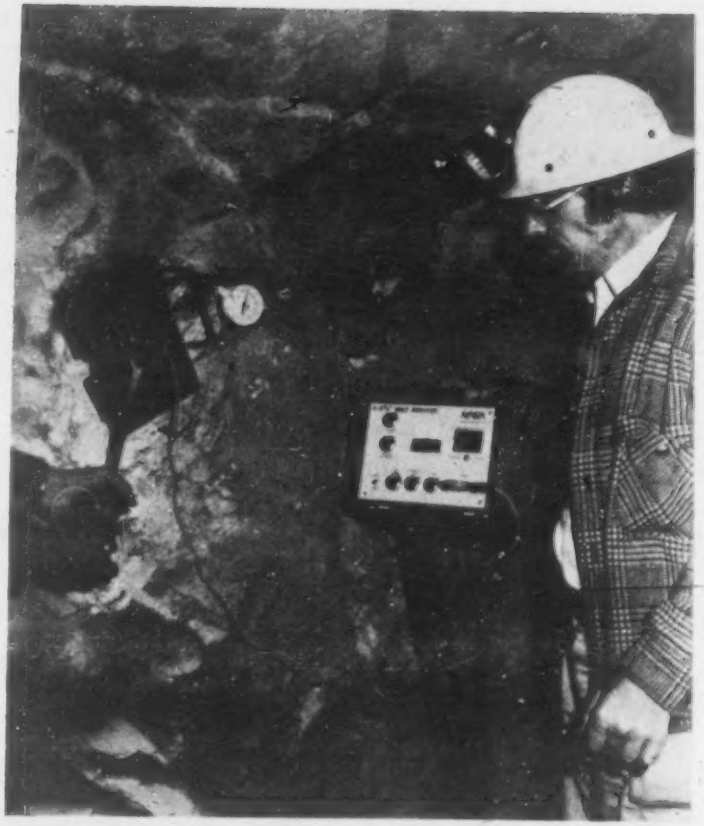


FIGURE 5

ROBOTICS

- NASA/JPL BEGINS LUNAR & MARS ROVER WORK 72-73
- ROBOTICS TECHNOLOGY DEMONSTRATED TO AMERICAN MANUFACTURERS (1979)
- UNIMATION/JPL COOPERATE ON THREE YEAR PROJECT TO EQUIP ROBOTS WITH SENSORS
- JPL COMPLETES 1ST YEAR NEEDS ANALYSIS
- PHASE (2) PROTOTYPE DEVELOPMENT INITIATED

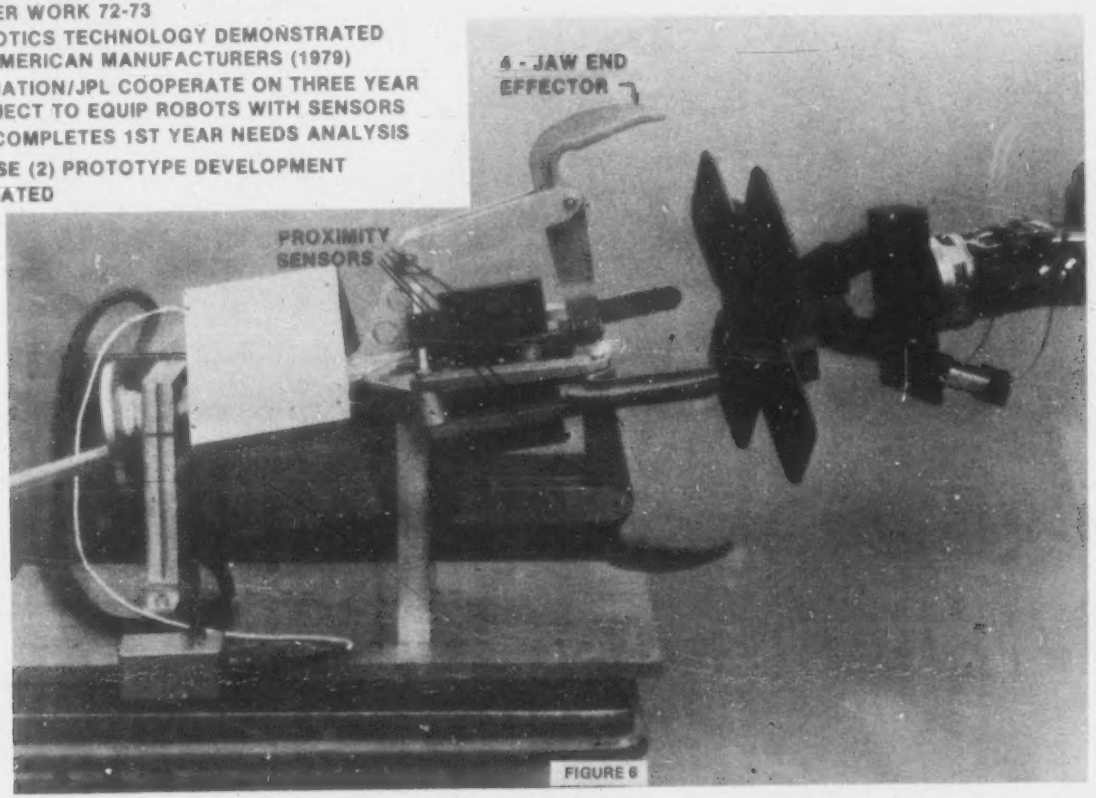


FIGURE 6

AIRCRAFT (STOWAWAY) WHEELCHAIR

- COOPERATIVE EFFORT ON ADVANCED WHEELCHAIR NASA/NIHR
- RESULT OF RIUSA'S ACCESS TO THE SKIES PROGRAM
- DOMESTIC & INTERNATIONAL EVALUATION
- DESIGN SELECTED BY UNITED AIRLINES

FIGURE 7

IMPROVED AUTOMATIC IMPLANTABLE DEFIBRILLATOR (AID II)

AID I

- AS OF JAN 1982 50 HAVE BEEN IMPLANTED
- 40 AUTOMATIC DEFIBRILLATIONS TO DATE
- MANUFACTURED BY INTEC-SYSTEMS, INC.

AID II

- TOTALLY IMPLANTABLE
- TREATS VENTRICULAR FIBRILLATION AND ARRHYTHMIAS
- INTERNAL RECORDING DEVICE

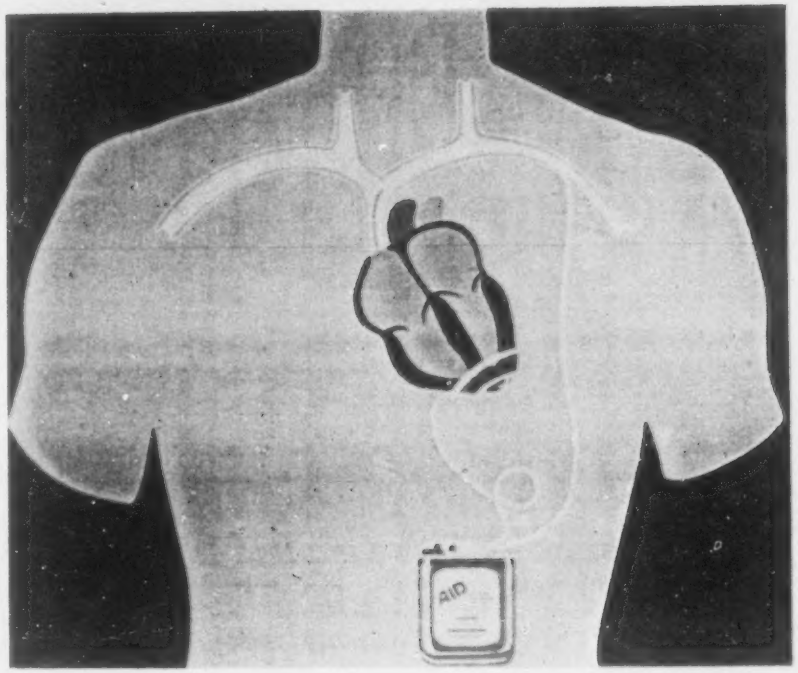


FIGURE 8

PIMS MEDICATION PROGRAMMING SYSTEM

- NASA/NIH/INDUSTRY DEVELOPMENT
  (PARKER HANNIFIN, WILSON GREATBATCH, INC., GTE, INC., PACESETTER, INC. AND NOVO)
- MICROMINIATURIZED, COMPUTER-DIRECTED
- PRECISELY CONTROLLED, PROGRAMMABLE MEDICATION DELIVERY SYSTEM
- DIABETES, HYPERTENSION, AND OTHER DISEASES

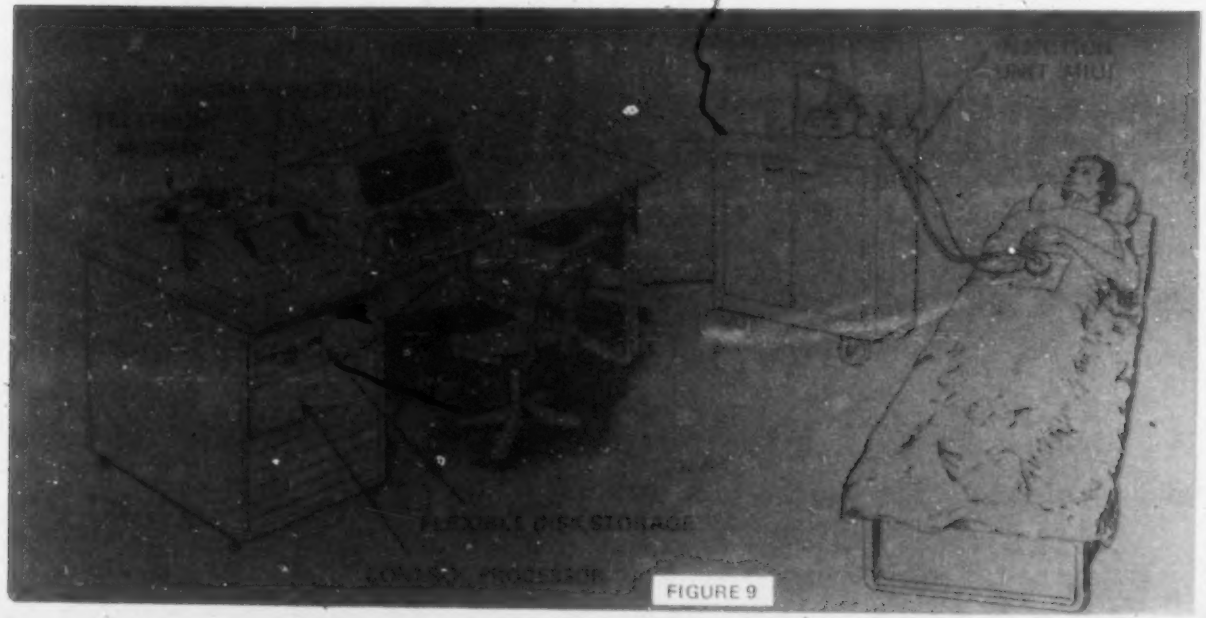


FIGURE 9

QUESTION 3:

The Stevenson-Wydler Act requires each Federal laboratory having an annual budget exceeding $20 million to establish an Office of Research and Technology Applications with one full-time staff member. Historically, NASA waives this requirement.

NASA, as usual, has submitted a request to waiver part of the Stevenson-Wydler Act requirements. This request states that "...each NASA field center has Technology Utilization officers and staff..." Yet, the Technology Utilization budget provides no funds in FY 1983 for 3 centers and 1 laboratory--Johnson, Kennedy, Lewis, and the National Space Technology Laboratory. The NASA Technology Transfer program receives no funds for FY 1983. Given these facts, do you expect your waiver request to be granted for FY 1983?

ANSWER 3:

Those activities which NASA conducts in-house and which contribute to meeting the intent of the Stevenson-Wydler Act are not funded from the research and development appropriation. As is true of the NASA in-house activities supporting all of our research and development, they are funded from the research and program management appropriation. Further, the basic documentation of new technology is paid by the program which funds that technology development, and it is an integral part of the program's technical reporting. All of these activities will be continued in FY 1983. The reduction in the Technology Utilization FY 1983 request actually represents a reduction in NASA funding for activities conducted by NASA under contract. The FY 1983 request represents a greater reliance on funding by user organizations, in the light of changing economic conditions and tax policies favoring investment in technological innovation.

The NASA in-house capability, on which the previous waiver of specific Stevenson-Wydler requirements was based, will remain. NASA funding for all of the activities we are conducting which are within the spirit and intent of that Act are estimated to exceed the Act's minimum funding requirements. Our activities will continue to be managed as a coherent, Agency-wide, national transfer effort; therefore, we believe that the NASA Administrator's waiver is in order.

QUESTION 4:

Mr. Philips, you mention NASA plans to investigate conversion of Tech Briefs to paid subscription. Yet, a February 1982 NASA report to this Committee, titled, Private Sector Involvement in the NASA Technology Utilization Program concludes that such a conversion is inadvisable. Do you disagree with that report?

ANSWER 4:

The referenced report is based on a study conducted by NASA in 1977. Based on a recent search of the literature and discussions with individuals knowledgeable in the field of technology transfer, NASA believes that current conditions warrant an indepth survey of a broad spectrum of users and publishers of technical information to determine if such a conversion is advisable. This investigation may also provide information leading to alternate approaches for achieving a

more cost-effective system.

QUESTION 5:

a. Has the reorganization helped the Technology Utilization program?

b. Do you think that Technology Utilization programs should be turned over to industry? If so, what evidence do you have that they will pick it up?

ANSWER 5:

a. While it is too early to cite specific results, it is believed that the NASA reorganization will benefit the Technology Utilization program by:

- facilitating broad interactions with all program offices and field centers;
- raising the level of program visibility, both internally and externally; and
- increasing Technology Utilization program interactions with other industry affairs efforts.

b. NASA has, over the years, turned the performance of substantial parts of the Technology Utilization program over to industry and to other private and public sector organizations. As our February report on Private Sector Participation states, there are many Technology Utilization program activities which industrial organizations can do best. In many cases, the industrial organizations have assumed significant funding responsibility.

We are now at a time when general economic trends and conditions, as well as significantly changed tax policies, suggest the possibility of further extending industry participation in the NASA Technology Utilization program. Given the proven economic value to industry of secondary uses of NASA technology, and the incentives available through the 1981 tax reforms, we believe that significantly greater industry funding for Technology Utilization program activities is possible.

Mr. FLIPPO. Thank you for your statement.

What I am interested in doing is determining exactly what the position of the administration is in regard to this program. Is NASA, is the administration in the process of turning this function over to the private sector? Is that the administration's position? Do you believe that the private sector will pick it up?

Mr. ALLNUTT. Let me have a try at that if I might, Mr. Chairman, and Ron may want to add some thoughts. This is a funding level, as you note, of about one-third the level we were at a couple of years ago. At this level we will not have as active a program and will not be able to do all of the things we were doing. Also at this level we are forced—and I think in part this may be healthy—to seek the maximum amount of private participation and private funding for some of these activities, and also contributions from other agencies with whom we are working on technologies that are of interest to them.

It is not at all planned, however, for NASA to phase out of this activity. There was some discussion of that a year or so ago and this committee voiced itself on that subject. We are not phasing out. We are going to continue the best program we can. We did a study, and I know that you are referencing to this in part, which we submitted recently on looking at all the ways we could to increase private involvement, and we think there may be some marginal ways in which that can be done. We are going to be looking also at charging for some of the publications that are now distributed without charge.

Therefore, we will do all we can to increase private involvement but the fact is that over the years this has evolved as a program with very heavy private involvement. Just to give one example, at the dissemination centers, taken as a whole now, our funding is only about one-third, with two-thirds coming from the sponsoring institutions and private subscribers. Therefore, there is a limit beyond which we are not going to get with that effort.

Mr. FLIPPO. Could you tell me the main constituency for this data—industry, university, private? I wonder what would be the reaction of that constituency if the dollar value were zero.

Mr. PHILIPS. Mr. Chairman, in the industrial application centers, last year there were about 15,000 industrial clients, of which about 20 percent were on a retainer basis. With zero funding in this program, it is not clear how many of the industrial application centers would continue. It is clear that they would not be as aggressive in transferring NASA technology without NASA support. They probably would move more toward a library service type function as opposed to an aggressive technology transfer type capability. The possibility is that some or all of those 15,000 firms would not have this service available to them and not have the access to NASA technology that they currently do. Of course, a very high percentage of the subscribers to the Tech Brief journal are in private industry. If the program were zeroed out, we would not be able to publish the Tech Brief journal because that is a major piece of the program. In addition, the technical backup packages which literally allow the bench scientist and engineer to exploit the technology would not be available either, so those services would not be available to those individuals and companies.

The partnership that is now in place between Government, universities, and industry by virtue of this program would probably be severed for practical purposes at that level. The application team activity—and I would like to point out that in the back of the room we have some examples of recent successful applications in the bioengineering area and in the manufacturing area that if you have the opportunity you may want to glance at because I think they are impressive—this kind of activity would not continue.

As one example the programable implantable medication system, on which I had the privilege of sitting in on a half-day briefing last week, involves NASA, the John Hopkins University, the Applied Physics Lab. the Parker Hannifin Corp., Pacesetters, Inc., Novo Corp. of Copenhagen, Denmark, and several other university medical schools. I believe the NASA program provides the glue that holds together. They will be implanting a device which holds great promise for the routine, automated treatment of diabetics in this country. Those kinds of activities would not be allowed to continue.

Mr. FLIPPO. Would it be unfair or wrong to view this budget level that is being requested as a "going out of business" act?

Mr. ALLNUTT. It wouldn't be unfair if you did it, Mr. Chairman. But, we do not plan to go out of business. It is clear that we will be limited in what we can do. The number of applications teams and the amount of support to dissemination centers is limited; but, you should not view it as a step toward going out of business in a year or two. That is not the plan.

Mr. FLIPPO. Just restructured for more effectiveness, I suppose?

Mr. ALLNUTT. It will be more effective, and it will be more limited.

Mr. FLIPPO. What are you doing in the handicapped area?

Mr. PHILIPS. In the handicapped area, in 1982, slightly more than 30 percent of the total TU budget was for applications work. Slightly over half of that, slightly more than $1 million, was in the bioengineering and rehabilitation area. Again, about a split of that was in the rehabilitation area. I do not want to get into a debate with my medical professional friends but I believe that a good deal of bioengineering work is also rehabilitation work. If you can assist someone with a heart problem, in a sense he has been rehabilitated. However, there are some very specific aids that we are in the process of working on: Aids for the blind and the crippled, people with chronic, disabling pain. We have those projects ongoing and we feel those are high priority projects.

We have a continuing relationship with the appropriate Institutes of Health in this area. One of the difficulties we have is assuring ourselves that they have prioritized their problems so that we can do an adequate job of matching NASA technology, getting on with the job, and securing the funds to allow the development to proceed, because in order for us to be efficient, we do need outside assistance. We do need mission agency assistance in carrying a project through the design, engineering, and prototyping phases.

Mr. FLIPPO. What area of your operations do you feel was most severely impacted by these budget cuts or, if the committee continued its support, what would be your priorities with increased funding?

Mr. PHILIPS. We would do more applications work. We would strengthen our dissemination activity slightly. We would clearly pick a number of highly prioritized applications projects that appear to have a high potential for success, a potential of actual utility in our society and pursue those very vigorously.

Mr. FLIPPO. Would the gentleman from New York have a question?

Mr. MCGRATH. I decline, sir, because I was not here.

Mr. FLIPPO. The gentleman from California?

Mr. LOWERY. I have no questions, Mr. Chairman.

Mr. FLIPPO. Your testimony has been clarified. There are no questions. Very good. Thank you very much.

Mr. PHILIPS. Thank you, sir.

Mr. ALLNUTT. Thank you, Mr. Chairman.

Mr. FLIPPO. The committee stands in recess until tomorrow morning.

[Whereupon, at 3:40 p.m., the subcommittee recessed, to reconvene at 9 a.m., on Thursday, March 4, 1982, in room 2325, Rayburn House Office Building.]

1983 NASA AUTHORIZATION

THURSDAY, MARCH 4, 1982

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS, SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

Washington, D.C.

The joint subcommittee met, pursuant to notice, at 9:35 a.m., room 2318, Rayburn House Office Building, Hon. Dan Glickman presiding.

Mr. GLICKMAN. Good morning, the Subcommittee on Space Science and Application and the Subcommittee on Transportation, Aviation and Materials will come to order.

These two subcommittees meet jointly to receive testimony on the NASA 1983 fiscal year budget request. We have several NASA witnesses today who will be testifying on a variety of issues involving program management as well as facilities at the NASA operations throughout the country.

But before we get to these witnesses I would be pleased and honored to hear from our distinguished colleague from Cleveland, Ohio, the Honorable Ron Mottl. I have no opening statement. Mr. Hollenbeck, do you?

Mr. HOLLENBECK. I have no formal opening statement, Mr. Chairman. I just, too, would like to join in welcoming our witnesses, including our distinguished colleague from Ohio.

Mr. GLICKMAN. Today we are together and not apart, right?

Mr. HOLLENBECK. Right.

Mr. GLICKMAN. Why don't you go ahead.

STATEMENT OF HON. RONALD M. MOTTL, MEMBER OF CONGRESS, 23D DISTRICT, STATE OF OHIO

Mr. MOTTL. Thank you very much, Mr. Chairman and members of the committee.

I am here this morning to testify about the NASA Lewis Research Center as an institution. As you recall, I testified before your subcommittee back on December 8. At that time, I emphasized the unique capability that NASA Lewis has for energy R. & D. and outlined their outstanding performance in carrying out Department of Energy programs. Today, I would like to say more about the laboratory as a vital Federal institution and what it means to Cleveland area residents, the State of Ohio, and this country. I also want to express my great concern about OMB's unfortunate tinkering with the lab's traditional role.

An institution, of course, is much more than brick and mortar, or even the hardware that makes up the unique test facilities at Lewis. The Lewis Center is a great deal more than simply 350 acres or 100 buildings, or even 555 specialized test installations. It is the collective contributions of some 2,600 dedicated civil servants, with outstanding skills using these facilities coupled with an average of several decades of high technology experience. It is also their ingenuity which has resulted in great contributions to developing a technology base for U.S. propulsion needs. It is, finally, a major repository of Federal corporate memory in aeronautics, space and energy conservation technology, a body of knowledge, a collection of lessons learned. It has been and is a center of excellence for not only doing all these things, but doing them very well. To us in Cleveland, the Lewis Center is a world class institution just like our orchestra and the Cleveland clinic.

As you are well aware, the aeronautics work at Lewis represents growth and learning accumulated over four decades of partnership with the U.S. military and aerospace industry. This fiscal year 1983 NASA budget tells us that despite these marvelous, successful partnerships, Lewis should narrow its role in aeronautical propulsion and space technology. We are being advised to ignore the $100 billion success that this Federal role has led to in terms of our balance of payments over the last 20 years.

In the midseventies, the managers of this institution of excellence made a decision to answer a pressing national need by playing a key role in energy R. & D. Today, the OMB has the temerity to tell the Congress that, despite their outstanding track record in energy, the country can no longer afford several hundred highly skilled people who have carried out these responsibilities. This is obviously shortsighted and I want to congratulate you on the letter you cosigned with Chairmen Fuqua and Flippo on the question of NASA's threatened personnel decisions in energy R. & D. In the face of the general consensus that the center has managed and done excellent basic research in energy R. & D., the projections are that its DOE program responsibilities will drop by a factor of 18 in funding from fiscal year 1982 to fiscal year 1983, from $56 million to about $3 million. I share the misgivings of this subcommittee and confess my utter disbelief that this administration feels it is any way in the national interest to virtually tear this center from its energy role.

I believe, Mr. Chairman, that the big losers, if such a tragic decision is finally implemented, will be the aerospace industry, the energy industry, the military, and the country. The losses will not be simply through the reductions in manpower which we understand to be nearly 200 during this fiscal year. There will be the loss of give and take between the researchers in aeronautics, energy, and space which has been so beneficial to the technological transfer process. Industry has always been the primary beneficiary of Lewis' work as the center has acted as the Government's technical broker.

I hope this subcommittee can dispell any notion that the Lewis Center or any other NASA center is a doomed institution. Lewis and the others have contributed too much to our national effort to become afterthoughts in advanced technology efforts, particularly

if we are serious about our international trade position. You and the committee will certainly have my support on the House floor in seeing that the space and energy budgets do justice to Lewis' and NASA's unique capabilities.

Mr. Chairman, if I may just cite an example of what one person—one of these 2,600 people—has contributed to our economy.

A NASA Lewis Research Center engineer was reported in the Cleveland Press on March 3—that was, I believe, yesterday—had received a $15,000 award from NASA for a breakthrough that spawned a new industry. S. Steven Papell of Berea, Ohio—incidentally, a resident of my district—was honored for his work on space propulsion which led to the development of processes that impart magnetic qualities to fluids. Papell's work began in 1963 when he was faced with the problem of restarting rocket engines under weightlessness. He hit on the idea of attracting the fluid fuel through the desired area with magnets and developed fine magnetized solid particles which would be suspended in the kerosene rocket propellant. That development has since triggered commercial production of magnetic fluids with estimated annual sales of $500 million. That's just one small contribution.

Now, Mr. Chairman, in conclusion, our fine Director out at Lewis, John McCarthy, has just tendered his resignation. This, to me, is deplorable. A man of competence and stature not to mention the great contributions he made to NASA is leaving the program. It is my humble opinion that the major reason he is leaving the program is the cuts in the proposed budget and also the cutting out and taking out, if you will, of the energy programs from NASA. And to lose a man of this capability, and others like him, is a tragedy that we can ill afford. Now, he is going to go back to MIT and we are going to lose this great man. It is really unfortunate, Mr. Chairman.

Mr. GLICKMAN. Ron, first of all, I want to thank you for your excellent testimony and also for the work that you have done in kind of spearheading the effort to acquaint the colleagues here in the House about the important work being done at the Lewis Center. I think that largely to the efforts of people like yourself we have been able to salvage the Lewis Center as an operating institution this year, but it is of great concern that yesterday the Department of Energy testified that they are going to eliminate the energy programs that NASA manages at the Lewis Center, although Dr. Kerrebrock, who is in charge of those programs at NASA here in Washington, did testify yesterday that if Congress provides funds for these programs NASA will, obviously, find a way to continue their support. And, also, we have held in the aeronautics area, where there are other major cuts besides the energy area, there is strong industry support for the continuation of these programs.

It is no secret this morning General Motors had their worst month of February in years and years, and it is just ridiculous to think that the automobile industry is going to pick up these programs in the basic research area that NASA is doing at Lewis Center. They are not, they don't have any money to hardly operate their institutions, yet, do any basic research. So I think that you will find there will be general agreement on this committee with

the thrust of your statement and we will do our best to work out the present situation.

Mr. MOTTL. Dan, I want to thank you, especially you and your subcommittee, for all the help you have given us for Lewis. We really appreciate it, and that is from all of Greater Cleveland.

Mr. GLICKMAN. Mr. Dunn.

Mr. DUNN. I would just like to follow up on what the chairman said, particularly in regards to the Director.

Dan and I were at Lewis last year and were immensely impressed with Mr. McCarthy and his dedication to what he is doing. I am also very concerned that DOE and NASA seem to have jointly decided that there is no more role for government in helping out our automobile industry; they have three specific engine programs going on which have been eliminated this year. And I asked the question yesterday that even if I were to agree that these three programs could be picked up by the automobile industry, are you telling me there is no role for DOE and NASA to be playing in terms of our biggest energy user, the automobile, in this country? I said, "So what other programs do you have in line to supplant these?" They did not have an answer for me, and I am extremely disappointed in that and would like to echo what the chairman had to say.

Mr. MOTTL. Thank you very much, Mr. Dunn.

Mr. GLICKMAN. Mr. Nelson.

Mr. NELSON. Mr. Chairman, I am concerned that sometimes in the name of economy we start to diminish our ability to respond in the development of our capability for the future. Not only the proposed cuts here that Ron has told us about, but in other areas, other areas of energy R. & D., other areas of the development of high technology, which have been explained that we can turn this over to the private sector and that development can occur there. Well, I think, to some degree that it can occur, but for us to adopt a policy that Government is going to turn all future R. & D. over to the private sector, outside of the defense area, I think is a shortsighted policy and one that will not serve this Nation well.

Now our colleague, Mr. Mottl, is here on behalf of a specific installation in his district, and, yet, I would like the record to reflect my concern with regard to the shortsighted policy as it applies to the entire country.

Mr. GLICKMAN. OK, Mr. Nelson.

Thank you, Ron, we appreciate your comment very much.

Mr. MOTTL. Thank you, too, Mr. Chairman.

Mr. GLICKMAN. OK, our next—by the way, I did not ask if there was any objection to the television coverage, and, hearing none, we may allow the televising of the proceedings.

Our next witnesses are all from NASA. I assume that we should take these one at a time. C. Thomas Newman, Comptroller, NASA.

All of your testimony will appear in the record in its entirety, so you may summarize as you deem appropriate.

STATEMENT OF C. THOMAS NEWMAN, COMPTROLLER, ACCOMPANIED BY TOM CAMPBELL, DEPUTY COMPTROLLER,

Mr. NEWMAN. Thank you, Mr. Chairman.

I believe that we have given the subcommittee both the larger package, which is about 37 pages, the one you just mentioned would be put in the record, and a smaller package which pulls pages from that. I would like to talk from that smaller package this morning. With me at the table is Mr. Tom Campbell, who is Deputy Comptroller of NASA.

This morning, I would like to cover an overview of the fiscal year 1983 budget, and comment on the fiscal year 1982 operating plan which is consistent with that budget and shown in the 1982 column of that budget. Then I would like to cover some economic considerations related to the NASA budget.

The first page is page 3—I have numbered the pages the same as in the large package—you can see that our total budget request is $6.6129 billion in budget authority and $6.582 billion in outlays. The budget is about 10.5 percent above the current fiscal year 1982 operating plan and about 20 percent above the fiscal year 1981 level. I have put in a page here just to summarize quickly the fiscal year 1983 budget content.

The space elements of the NASA program focus on completing the flight testing and establishing the operational capability, of the Space Shuttle and the related systems. While we will continue in the exploration of the solar system, in the expansion of our knowledge of the universe, and in the practical application of space capabilities, the major emphasis in the program, as I mentioned, is on the use of the Space Shuttle, on establishing that operational capability, and the production of four orbiters on essentially the same schedule as we presented to the subcommittee last year.

In space science, we have the Galileo mission to Jupiter, planned for launch in 1985; the space telescope to provide a quantum jump in our ability to observe the universe, which is also scheduled for launch in 1985; the Gamma Ray Observatory to study the extremely high energy regions of the spectrum, scheduled for launch in late 1988. We have emphasized the development of advanced scientific instruments required to take advantage of the spacelab capabilities. Those are all in the space science program.

In Applications, we will launch the Landsat-D this year, and we will operate that spacecraft experimentally as the next step in earth resources observations from space. Also under development is the Earth radiation budget experiment to measure the exchange of energy between the Earth and space. In fiscal year 1982, we have a plan to launch the search and rescue locator system on weather satellites. That will begin the experiments with that system. We are working on the instruments for an advanced upper atmosphere research satellite.

In space research and technology, we are, of course, emphasizing the longer range technologies critical to future U.S. leadership in space.

In Aeronautics, as you are well aware, the emphasis is placed on the research and technology base. Specific systems technology efforts will continue both in the low speed area with emphasis on rotorcraft and powered lift and in the high performance aircraft systems technology areas.

On page 4, I have outlined how we got to our present fiscal year 1982 operating plan. You may remember that in January 1981 our

budget request pending before the Congress was slightly over $6.7 billion. That was adjusted in the March budget amendment to $6.122 billion. The Authorization Act was $50 million above that, for a total of $6.172 billion. The appropriations before provision for the 4-percent reduction would have been $6.187 million, but the 4-percent reduction resulted in an overall reduction of $247 million from that figure. We have appropriated and available to us $5.940 billion.

To cover the cost of the civil service pay raises which took effect in October and January of this fiscal year, we need an additional $41 million. Therefore, that is why the fiscal year 1982 column of our fiscal year 1983 budget shows the figure of $5.981 million.

I have summarized all that on page 4.

The pages numbered 6 and 7 detail what we did to get down to the figure in the fiscal year 1982 operating plan. I believe you have been over most of this in the hearings; but very briefly, the Shuttle was reduced by a net of $31 million. In the process, we reallocated the funds that were budgeted for changes and systems upgrading to the areas where they have been applied: $158 million in the D.D.T. & E. program and $106 million in the production program.

We also brought into the Shuttle program in fiscal year 1982 the development of the performance augmentation approach using the filament wound case. We had budgeted $5 million for study of performance augmentation alternatives. During the past year, we arrived at the conclusion that the most effective way to proceed was with the filament wound case to lighten the weight of the solid rocket boosters. We are proposing to apply the $5 million to initiation of that development and the total cost of the development and procurement of the initial flight sets is about $250 million.

In Space Flight Operations, the major changes are those related to discontinuing the Centaur development and planning to use the inertial upper stage as a launch vehicle for the planetary missions as well as for the tracking and data relay satellite. You can see that reduced the requirement in development of upper stages from $75 million to $23 million, but there is a partial offsetting increase in the requirement for procurement of upper stages under STS operations from $40 million to $67 million.

In Shuttle Operations, we found it necessary to put some increases in that area. At the time of the fiscal year 1982 budget amendment, we took a major cut in that area—something over $100 million. We adjusted the flight rate, but as we shook down the flight rate and reviewed it in depth, we determined that we needed to program some additional funding into that area to hold to the present plan which provides 32 flights through fiscal year 1985.

In space science, I have put down the major elements that result in the reduction of $16 million. The deletion of the Venus orbiting imaging radar is a major element of that. The reductions in planetary research and analysis is another major element. We did have to increase the Galileo project by $12 million in fiscal year 1982, and that increase relates essentially to providing a propulsion unit that is necessary when you launch the Galileo as a single launch using an inertial upper stage.

In Applications, we made a number of significant reductions in geodynamics, Agristars environmental observations, and communi-

cations, but we did provide some increases such as an increase in Upper Atmosphere Research Satellite, experiment funding, technology transfer, and technology utilization.

In Aeronautics, there is a slight increase in the research and technology base, but a significant decrease in the systems technology efforts.

In Research and Program Management, we cut $11 million, but the figure that we are planning in fiscal year 1982 is up by a net of $30 million because of the cost of the pay raises.

On page 8 for your reference I have listed the actions that we have sent to the Congress in implementation of the fiscal year 1982 operating plan. There are a number of changes that involve reprograming actions, other actions on which we have requirements to formally notify the Congress, and those actions that are all signed and before the Congress.

One of those actions involves the mission to retrieve the solar maximum mission satellite, to capture that satellite and repair it in orbit. On page 9 I have shown the cost in fiscal years 1982 and 1983 associated with that effort: $18 million in fiscal year 1982 and $24 million in fiscal year 1983. There is about $6 million in subsequent years, so the total mission cost is in the range of $45 to $55 million.

Page 10 is a brief summary of the trends that are shown in the budget. The budget as a whole is up 10.5 percent. Research and development is up about 12.6 percent; and if you look at the space transportation area as a whole, they are up about 12 percent. So the ratio of increase from fiscal year 1982 to 1983 is about the same in space transportation as it is in research and development on a whole. There is significant emphasis in space transportation. We are planning to complete the D.D.T. & E. program on schedule and move into operations; you can see the large increase in operations. That is in large part because the STS operations now assume the responsibility for the activities at KSC and at JSC in support of the operational functions. It also reflects an increase in the funding required to buy the number of expendable tanks and solid rocket boosters to support the operational flight missions.

Space Science is up 20 percent over the fiscal year 1982 level and about 26 percent over the fiscal year 1981 level. The major elements of the increase are that we are getting into the development phase of the gamma ray observatory. We will be putting increased emphasis on instruments which take advantage of the Spacelab capability. The Space Telescope development efforts are increasing as well as the International Solar Polar Mission—the ISPM. You can see the additional funding required to provide the auxiliary propulsion necessary when that mission is launched on an inertial upper stage. There is a major increase shown here in other science projects. A large portion of that, about $30 million, is really associated with preparations for the operation of the Space Telescope.

In Aeronautics, the emphasis shown here, again, is clear. We are increasing the research and technology base by about $19 million, with a roughly offsetting decrease in the systems technology efforts. I have detailed those changes on the next page.

In Tracking and Data Acquisition, we show a large increase on page 10 in the funding requirements, primarily because we are

starting payments on the tracking and data relay satellites system and at the same time keeping many of the ground stations open during the transition period.

On page 11, I have detailed the changes in the aeronautics program. I think these have been basically presented to the subcommittee by the previous witnesses. The research and technology base is up significantly. The low speed aircraft systems technology activities are maintained and somewhat increased over the fiscal year 1982 level. The high speed aircraft systems technology efforts are also increased and the other systems technology efforts are basically phased out during fiscal year 1982 so they do not require further funding in fiscal year 1983.

Page 12 is a quick summary of the overall Space Shuttle program. The total estimate, at present, for completion of the Shuttle D.D.T. & E. program is about $10 billion. In terms of 1971 dollars, this would equate to $6.748 billion. It is about 31 percent above the $5.15 billion in 1971 dollars estimate that we had when the program was initiated. You can also see the total requirements for production and the total estimated cost of $250 million for the filament wound case.

On page 17, I have provided the flight schedule. I was trying to show in part the transition of our activities from the expendable launch vehicle missions to the Shuttle, and I should have put on there the numbers of Shuttle flights involved. In fiscal year 1983, there will be five Shuttle operational missions. In fiscal year 1984, that number increases to ten, and we are planning 13 in fiscal year 1985. Those missions, plus the four flight test missions, are the 32 missions through fiscal year 1983 that we have been talking about.

Page 20 is a summary of the multi-year projections that are contained in the President's budget for the NASA programs. You can see that the total for NASA goes from $6.6 billion in fiscal year 1983 to about $5.4 in fiscal year 1987 which is a decrease of $1.2 billion over that period. During that same period, the projected requirements for space transportation dropped by about $1.3; so, there is a slight increase in the dollar figure shown for all of the other program areas. These figures are intended to include future year inflation at the rates indicated near the bottom of the page which are the President's projection of the GNP deflator.

If that deflator is applied, then you get the approximate equivalent in constant fiscal year 1983 dollars and on that basis the total would decrease from about the $6.6 billion to about $4.7 billion, or a decrease of about $1.9 billion in constant dollars over that period.

On page 27, is the table that I have given you in previous years which shows the experience that we have had with inflation over the past several years. If you look at the trend since fiscal year 1976, you can see that we have had some ups and downs. We have essentially gone up 86 percent in actual dollars, and just about broken even in terms of constant dollars. I have put on this chart, also, that, based on our surveys, we project an inflation rate on the order of 9 percent in the current fiscal year, and probably about the same in fiscal year 1983. The projections in the President's budget show 7.9 percent in fiscal year 1982 and about 6 percent in fiscal year 1983. If you apply those, we would have increases in the

current period above the 1981 and 1982 level, and, also, we would be slightly better off relative to the 1976 level.

Now, one of the things that I should say about our inflation analysis is that our space and aeronautics work is very labor intensive. About 80 percent of the NASA expenditures go directly to pay the salaries of people working on the program. Our inflation has traditionally run 1 percent to 2 percent above the GNP deflator rates, but I question whether the aerospace industry is inflating faster than the economy as a whole. If you look at the Bureau of Labor Statistics rates for compensation per hour for nonagricultural workers over the years, they have been very close to the rate that we end up projecting. Our projections are based on surveys of the contractors we deal with. The Bureau of Labor Statistics (BLS) survey, of course, is much broader, but the results come very close in terms of compensation per hour.

The graph on page 26 shows the trend since 1976 and also, then, takes us back to about 1966. In terms of constant dollars, we are about a third of the level that we were in 1966, although in terms of actual dollars we are just about back at that same dollar level.

On page 29, I've shown estimates of the people who are involved in NASA work. In addition to the 21,000 civil service, we are estimating there are about 107,000 people at contractor and subcontractor plants who work directly on NASA programs. If you apply a multiplier effect, which we think is reasonable, of about 2.5 that would say that something over 300,000 jobs are generated by the NASA programs, and those jobs are of a high technology type that tend to stimulate the economy as well as the technical development of the country. That leads to some of the points that are made on page 30.

I believe Congressman Mottl gave an excellent example of just the type of thing we are talking about here, where work done at the Lewis Research Center did stimulate a major growth in a new item that had a significant economic impact. We believe that that effect takes place broadly in the program, and that there is no question that NASA activities over the years have stimulated progress in the economy as a whole, have led to new capabilities in both aerospace and nonaerospace segments of the economy, and have been a significant factor in achieving the favorable balance of trade in the aerospace segment of the economy which was about $13 billion in 1981.

Mr. Chairman, that concludes my prepared remarks.

[The prepared statement, plus answers to questions asked of Mr. Newman, follow:]

NASA
National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness
March 4, 1982

Subcommittee on Space Science and Applications

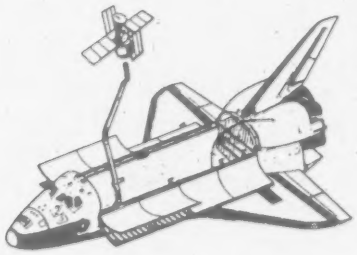
Subcommittee on Transportation, Aviation and Materials

Committee on Science and Technology

House of Representatives

Statement by:

C. Thomas Newman
Comptroller



97th Congress

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FY 1983 BUDGET OVERVIEW

I. SUMMARY OF FY 1983 PROGRAM AND REQUIREMENTS

II. PROGRAM ACTIVITY BY CENTER

III. IMPACT OF INFLATION

IV. EMPLOYMENT IMPACT AND ECONOMIC BENEFITS OF NASA ACTIVITY

V. SUPPLEMENTARY RESEARCH AND DEVELOPMENT BUDGET DATA

I. SUMMARY OF FY 1983 PROGRAM AND REQUIREMENTS

National Aeronautics and Space Administration

SUMMARY OF BUDGET REQUEST
(millions of dollars)

BUDGET PLAN	FY 1981	FY 1982 Current Estimate	FY 1983 Request Pending
Research and development	4334.3	4738.0	5334.0
Construction of facilities	117.0	98.7	100.0
Research and program management	1071.1	1144.7	1178.9
TOTAL BUDGET PLAN	5522.4	5981.4	6612.9
OUTLAYS	5425.6	5831.0	6582.0

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(millions of dollars)

	Budget Plan		
	FY 1981	FY 1982	FY 1983
RESEARCH AND DEVELOPMENT			
Space Transportation Systems	2,728.6	3,090.1	3,467.8
Space Shuttle	1,995.0	2,163.0	1,718.0
Space flight operations	679.2	895.9	1,707.0
Expendable launch vehicles	54.4	31.2	42.8
Space Science	541.5	568.0	682.0
Physics and astronomy	323.7	323.5	471.7
Planetary exploration	175.6	205.0	154.6
Life sciences	42.2	39.5	55.7
Space and Terrestrial Applications	340.3	333.8	320.3
Space applications	331.5	325.8	316.3
Technology utilization	8.8	8.0	4.0
Aeronautics and Space Technology	384.0	344.0	355.0
Aeronautical research and technology	271.4	233.0	232.0
Space research and technology	110.7	111.0	123.0
Energy technologyy	1.9	---	---
Tracking and Data Acquisition	339.9	402.1	508.9
TOTAL RESEARCH AND DEVELOPMENT	4,334.3	4,738.0	5,334.0
CONSTRUCTION OF FACILITIES	117.0	98.7	100.0
RESEARCH AND PROGRAM MANAGEMENT	1,071.1	1,144.7	1,178.9
TOTAL	5,522.4	5,981.4	6,612.9
CIVIL SERVICE POSITIONS	21,873	21,652	21,219

National Aeronautics and Space Administration

FY 1982 OPERATING PLAN
(millions of dollars)

	Amended Budget	Authorization Enacted	Appropriation before Reduction	Application of Reduction		Civil Service Pay Raise Requirement	Current Estimate
Research and Development	4903.1	4953.8	4973.1	-235.1	4738.0	---	4738.0
Construction of Facilities	104.8	104.1	99.8	-1.1	98.7	---	98.7
Research and Program Management	1114.3	1114.3	1114.3	-11.0	1103.3	+41.4	1144.7
Total	6122.2	6172.2	6187.2	-247.2	5940.0	+41.4	5981.4
Change from Amended Budget		+50.0	+65.0		-182.2		-140.8

National Aeronautics and Space Administration

FY 1982 OPERATING PLAN
(millions of dollars)

RESEARCH AND DEVELOPMENT	Amended Budget Plan	Revision	Current Estimate
Space Transportation Systems	3136.1	-46.0	3090.1
Space Shuttle	2194.0	-31.0	2163.0
Space flight operations	910.9	-15.0	895.9
Expendable launch vehicles	31.2	---	31.2
Space Science	584.2	-16.2	568.0
Physics and astronomy	325.4	-1.9	323.5
Planetary exploration	215.3	-10.3	205.0
Life sciences	43.5	-4.0	39.5
Space and Terrestrial Applications	377.5	-43.7	333.8
Space applications	372.9	-47.1	325.8
Technology utilization	4.6	+3.4	8.0
Aeronautics and Space Technology	390.1	-46.1	344.0
Aeronautical research and technology	264.8	-31.8	233.0
Space research and technology	125.3	-14.3	111.0
Tracking and Data Acquisition	415.2	-13.1	402.1
TOTAL RESEARCH AND DEVELOPMENT	4903.1	-165.1	4738.0
CONSTRUCTION OF FACILITIES	104.8	-6.1	98.7
RESEARCH AND PROGRAM MANAGEMENT	1114.3	+30.4	1144.7
TOTAL	6122.2	-140.8	5981.4

National Aeronautics and Space Administration

FY 1982 OPERATING PLAN
(millions of dollars)

	March Budget Request	Change	Current Estimate
RESEARCH AND DEVELOPMENT			
Space Transportation Systems			
Space Shuttle	2194.0	-31.0	2163.0
DDT&E	740.0	+158.0	898.0
Production	1154.0	+106.0	1260.0
Changes & Systems Upgrading	300.0	-300.0	---
Performance Augmentation (FWC)	---	+5.0	5.0
Space Flight Operations	910.9	-15.0	895.9
Upper Stages Development	75.0	-51.8	23.2
Upper Stages Operations	40.0	+27.5	67.5
Shuttle Operations	396.0	+39.3	435.3
Payload Support Operations	28.2	-8.0	20.2
Spacelab	110.7	-9.9	100.8
Other Space Flight Operations	261.0	-12.1	248.9
Expendable Launch Vehicles	31.2	---	31.2
Space Science	584.2	-16.2	568.0
Shuttle/Spacelab Payloads	35.0	+5.0	40.0
Space Telescope Development	119.5	+2.0	121.5
Galileo	108.0	+12.0	120.0
Venus Orbiting Imaging Radar	10.0	-10.0	---
Mid-Level Facility	---	+1.7	1.7
Research and Analysis	119.8	-16.4	103.4
Planetary Mission Operations and Data Analysis	45.8	-7.5	38.3
Other Science Projects	146.1	-3.0	143.1

	March Budget Request	Change	Current Estimate
Space & Terrestrial Applications	377.5	-43.7	333.8
Geodynamics/Laser Network Operations	30.9	-8.0	22.9
AgRISTARS	23.1	-9.1	14.0
Environmental Observations Research and Analysis	94.7	-17.3	77.4
Communications Research and Analysis	30.3	-9.4	20.9
Materials Processing	27.7	-3.9	23.8
Upper Atmospheric Research Satellite Experiments	5.0	+1.0	6.0
Technology Transfer	---	+5.0	5.0
Technology Utilization	4.6	+3.4	8.0
Other Applications	161.2	-5.4	155.8
Aeronautical Research and Technology	264.8	-31.8	233.0
R&T Base	157.8	+4.7	162.5
Systems Technology	107.0	-36.5	70.5
Space Research and Technology	125.3	-14.3	111.0
Tracking and Data	415.2	-13.1	402.1
Total Research and Development	4903.1	-165.1	4738.0
Construction of Facilities	104.8	-6.1	98.7
Research and Program Management	1114.3	-11.0	1103.3
Civil Service Pay Raise	---	+41.4	41.4
Total NASA Budget Authority	6122.2	-140.3	5981.4
Civil Service Staff Full Time Permanent	21,873	-221	21,652

National Aeronautics and Space Administration

PENDING ACTIONS

Action	Content	Status
Filament Wound Case -Section 4 of Authorization Bill	$5 million from Operations Capability Development to Space Shuttle	signed by Administrator 2/3/82
EXPO/Space Platform -adjustment to op plan (H.Rpt 96-1476 & agreements with Authorization Committees)	$3 million in FY 1981 funds from SEPS to Advanced Programs	signed by Administrator 2/5/82
Space Telescope -request for approval of Appropriations Committees to exceed ceiling of $119.5 million in P.L. 97-101	$2 million from Space Telescope Operations to Space Telescope Development	signed by Adminsitrator 2/18/82
Galileo/STS Upper Stages/Upper Stages Operations -Section 4 of Authorization Bill -request for approval of Appropriations Committees to exceed ceiling of $108 million for Galileo in P.L. 97-101 -request for approval of Appropriations Committees to exceed ceiling of $40 million for Upper Stages Operations in P.L. 97-101	$12 million from STS Upper Stages Development to Galileo Development; $27.5 million from STS Upper Stages Development to Upper Stages Operations	signed by Administrator 2/22/82
SMM repair/retrieval mission -Section 4 of Authorization Bill -H.Rept 96-1476 requirement	$9 million allocation within Physics and Astronomy; $3.2 million from Changes and Systems Upgrading to Space Shuttle Production; $6 million from Upper Stages Development to STS Operations	signed by Administrator 2/19/82
KSC CofF LC-39 Housing -Section 3 of Authorization Bill	$2.71 million reallocation within CofF from residual funds for other CofF projects	signed by Administrator 2/9/82

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National Aeronautics and Space Administration

Satellite Retrieval and Repair Mission
(Solar Maximum Mission)

Activity	Budget Authority In Millions of Dollars FY 1982	FY 1983
Physics and Astronomy - detailed mission planning, refurbishment of the Landsat spare attitude control system module, and procurement of items necessary to repair three of the Solar Maximum Mission's science instruments	9.0	9.2
Space Shuttle - Training and other support for the Manned Maneuvering Unit and other crew equipment required to perform the mission	3.2	6.5
STS Operations - mission planning, crew training, flight support equipment, flight operations integration	6.0	8.0
Total	18.2	23.7
*Total All-Years		45-55

National Aeronautics and Space Administration

FY 1983 BUDGET TRENDS
(millions of dollars)

	FY 1981	FY 1982 Operating Plan	FY 1983 Budget Estimate	'82 Op Plan to '83 Budget Change	'82 Op Plan to '83 Budget % Change
Research and Development					
Space Transportation Systems	2728.6	3090.1	3467.8	+377.7	+12.2%
Space Shuttle	1995.0	2163.0	1718.0	-445.0	-20.6%
DDT&E	973.0	898.0	—	-898.0	
Production	1022.0	1260.0	1585.5	+325.5	
Changes & Systems Upgrade	—	—	72.5	+72.5	
Performance Augmentation	—	5.0	60.0	+55.0	
Space Flight Operations	679.2	895.9	1707.0	+811.1	+90.5%
STS Operations	263.4	523.0	1414.1	+891.1	
Other Space Flight Operations	415.8	372.9	292.9	-80.0	
Expendable Launch Vehicles	54.4	31.2	42.8	+11.6	+37.1%
Space Science	541.5	568.0	682.0	+114.0	+20.1%
ISPM	28.0	5.0	21.0	+16.0	
Gamma Ray Observatory	8.2	8.0	34.5	+26.5	
Spacelab Payloads	27.4	40.0	81.4	+41.4	
Space Telescope Development	119.3	121.5	137.5	+16.0	
Galileo	63.1	120.0	92.6	-27.4	
Other Science Projects	295.5	273.5	315.0	+41.5	
Space & Terrestrial Applications	340.3	333.8	320.3	-13.5	-4.0%
Aeronautical Research and Technology	271.4	233.0	232.0	-1.0	-.4%
R&T Base	133.8	162.5	182.0	+19.5	
Systems Technology	137.6	70.5	50.0	-20.5	
Space R&T/Energy	112.6	111.0	123.0	+12.0	+10.8%
Tracking and Data	339.9	402.1	508.9	+106.8	+26.6%
Total Research and Development	4334.3	4738.0	5334.0	+596.0	+12.6%
Construction of Facilities	117.0	98.7	100.0	+1.3	+1.3%
Research and Program Management*	1071.1	1144.7	1178.9	+34.2	+3.0%
Total NASA Budget Authority	5522.4	5981.4	6612.9	+631.5	+10.6%

*1982 operating plan and 1983 budget fund 1981 pay increases

National Aeronautics and Space Administration

AERONAUTICAL RESEARCH AND TECHNOLOGY
(millions of dollars)

	FY 1981	FY 1982	FY 1983	Change FY 1982-1983
TOTAL AERONAUTICAL RESEARCH AND TECHNOLOGY	271.4	233.0	232.0	-1.0
RESEARCH AND TECHNOLOGY BASE	133.8	162.5	182.0	+19.5
SYSTEMS TECHNOLOGY	137.6	70.5	50.0	-20.5
Materials and structures systems technology	8.7	6.6	---	-6.6
Propulsion systems technology	4.4	.5	---	-.5
Avionics and flight control systems	1.2	1.3	---	-1.3
Aeronautical systems studies	3.1	---	---	---
General aviation	1.1	---	---	---
Low-speed aircraft systems technology	23.5	25.6	30.0	+4.4
Rotorcraft operating systems	0.9	1.4	1.5	+0.1
Powered-lift technology	1.7	0.3	---	-0.3
Advanced rotor sys tech/RSRA operations	6.1	6.4	5.6	-0.8
Tilt rotor systems technology	0.8	1.0	---	-1.0
V/STOL systems technology	2.6	---	---	---
Advanced rotorcraft technology	3.5	7.8	13.5	+5.7
Low-speed simulation & flt sys support	7.9	8.7	9.4	+.7
High-speed aircraft systems technology	16.6	7.7	20.0	+12.3
Supersonic cruise research	10.8	---	---	---
High-performance flight research	4.1	6.3	13.3	+7.0
Highly-maneuverable aircraft technology	1.7	1.4	1.1	-0.3
Turbine engine hot section technology (previously materials and structures)	---	---	5.6	+5.6
Transport aircraft systems technology	32.8	13.4	---	-13.4
Laminar flow control	4.6	4.0	---	-4.0
Energy efficient transport	14.9	3.0	---	-3.0
Composite primary aircraft structures	6.1	4.9	---	-4.9
Terminal configured vehicle	7.2	1.5	---	-1.5
Advanced propulsion systems technology	46.2	15.4	---	-15.4
Energy efficient engine	36.8	11.2	---	-11.2
Variable cycle engine technology	6.3	---	---	---
Advanced turboprop systems	3.1	4.2	---	-4.2

National Aeronautics and Space Administration

SPACE SHUTTLE
BUDGET AUTHORITY - FY 1983 DOLLARS

(millions of dollars)

	Prior Years	FY 1982	FY 1983	Balance To Complete	Total All Years
DDT&E	9,185	898	--	--	10,083
CHANGES/SYSTEMS UPGRADING	--	--	73	420	493
PRODUCTION	2,257	1,260	1,585	2,102	7,204
PERFORMANCE AUGMENTATION	--	5	60	185	250
TOTAL	11,442	2,163	1,718	2,707	18,030

DDT&E	1971 $ EQUIVALENT
Original Est. '71 $'s	$5,150 million
Current Est.	6,748 million
Increase	$1,598 million = 31%

National Aeronautics and Space Administration

SPACE FLIGHT OPERATIONS
(millions of dollars)

	FY 1981	FY 1982	FY 1983	Change FY 1982-1983
TOTAL SPACE FLIGHT OPERATIONS	679.2	895.9	1707.0	+811.1
Upper stages development	38.3	23.2	32.0	+8.8
Operations capability development	43.4	56.1	53.4	-2.7
DTMS/Engineering Technical Base	183.5	184.0	82.4	-101.6
Advanced Programs	11.8	8.8	11.9	+3.1
Spacelab	138.8	100.8	113.2	+12.4
STS Operations	263.4	523.0	1414.1	+891.1
Shuttle Operations	(213.5)	(435.3)	(1316.6)	(+881.3)
Upper Stages Operations	(30.9)	(67.5)	(63.0)	(-4.5)
Payload Support Operations	(19.0)	(20.2)	(34.5)	(+14.3)

National Aeronautics and Space Administration

SPACE SCIENCE
(millions of dollars)

	FY 1981	FY 1982	FY 1983	Change FY 1982-1983
TOTAL SPACE SCIENCE	541.5	568.0	682.0	+114.0
Physics and Astronomy	323.7	323.5	471.7	+148.2
Space telescope development	119.3	121.5	137.5	+16.0
International solar polar mission development	28.0	5.0	21.0	+16.0
Gamma ray observatory development	8.2	8.0	34.5	+26.5
Shuttle/Spacelab payload development and mission management	27.4	40.0	81.4	+41.4
Explorer development	33.3	33.3	34.3	+1.0
Mission operations and data analysis	38.9	50.0	85.6	+35.6
Research and analysis	37.7	32.9	39.2	+6.3
Suborbital program	30.9	32.8	38.2	+5.4
Planetary Exploration	175.6	205.0	154.6	-50.4
Galileo development	63.1	120.0	92.6	-27.4
Mission operations and data analysis	61.8	38.3	26.5	-11.8
Research and analysis	50.7	45.0	35.5	-9.5
Mid-level facility	---	1.7	---	-1.7
Life Sciences	42.2	39.5	55.7	+16.2
Life sciences flight experiments	12.7	14.0	24.0	+10.0
Research and analysis	29.5	25.5	31.7	+6.2

National Aeronautics and Space Administration

SPACE AND TERRESTRIAL APPLICATIONS
(millions of dollars)

	FY 1981	FY 1982	FY 1983	Change FY 1982-1983
TOTAL SPACE AND TERRESTRIAL APPLICATIONS	340.3	333.8	320.3	-13.5
Resource Observations	151.3	146.4	132.2	-14.2
Landsat-D	88.5	83.9	61.7	-22.2
Shuttle/Spacelab payload development	2.0	3.3	2.8	-.5
Geodynamics/laser network operations	23.4	22.9	26.2	+3.3
Applied research and data analysis/ related activities	12.8	19.5	24.7	+5.2
AgRISTARS	21.4	14.0	15.0	+1.0
Other activities	3.2	2.8	1.8	-1.0
Environmental Observations	104.1	116.5	128.9	+12.4
Earth radiation budget experiment	20.3	24.0	24.0	---
Halogen occultation experiment	4.5	5.0	---	-5.0
Shuttle/Spacelab payload development	1.7	4.1	3.7	-.4
Applied research and data analysis/ related activities	61.6	60.0	71.2	+11.2
Upper atmospheric research satellite experiment	---	6.0	14.0	+8.0
Other activities	16.0	17.4	16.0	-1.4
Application Systems	18.1	13.2	11.7	-1.5
Technology Transfer	8.1	5.0	---	-5.0
Materials Processing	18.7	23.8	23.6	-.2
Shuttle payload development/experiment ops.	9.5	11.8	10.5	-1.3
Applied research and data analysis	9.2	12.0	13.1	+1.1
Communications and Information	31.2	20.9	19.9	-1.0
Systems	4.8	2.3	3.7	+1.4
Search and rescue	21.9	13.6	8.7	-4.9
Communications applied research and analysis/ related activities	4.5	5.0	7.5	+2.5
Data systems	8.8	8.0	4.0	-4.0
Technology Utilization				

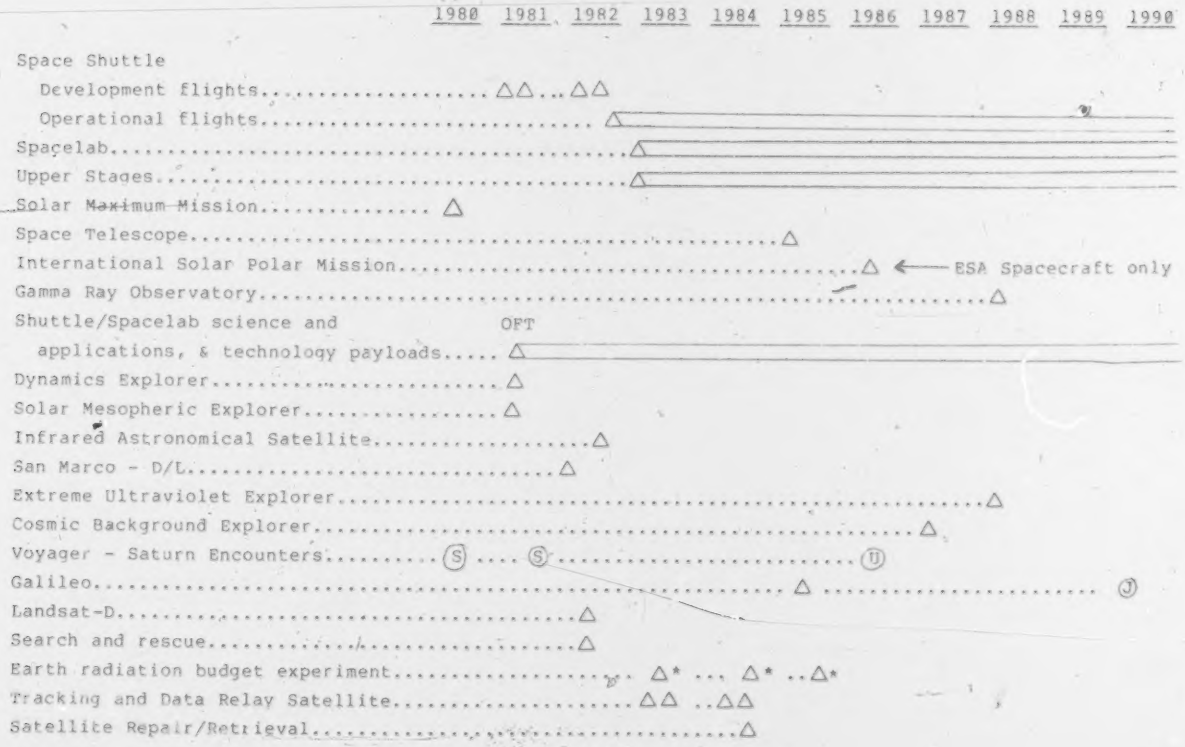
National Aeronautics and Space Administration

TRACKING AND DATA ACQUISITION
(millions of dollars)

	FY 1981	FY 1982	FY 1983	Change FY 1982-1983
TOTAL TRACKING AND DATA ACQUISITION	339.9	402.1	508.9	+106.8
Operations	266.5	300.5	338.2	+37.7
Systems implementation	62.1	89.1	96.0	+6.9
Advanced systems	11.3	12.5	13.4	+.9
Tracking and data relay satellite system	---	---	61.3	+61.3

National Aeronautics and Space Administration

FLIGHT ACTIVITY



*Currently under review

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National Aeronautics and Space Administration

CONSTRUCTION OF FACILITIES
SUMMARY

	FY 1983 (thousands of dollars)
DRYDEN FLIGHT RESEARCH FACILITY	4,500
o Construction of Data Analysis Facility	
GODDARD SPACE FLIGHT CENTER	2,840
o Rehabilitation and Modification of Utility Systems	
LANGLEY RESEARCH CENTER	16,200
o Modifications to Upgrade the Transonic Dynamics Tunnel	9,000
o Modifications to the 4- by 7-Meter Low Speed Tunnel	7,200
LEWIS RESEARCH CENTER	3,915
o Modification of Rocket Engine Test Facility for Altitude Testing	995
o Modifications to 450 PSI Air System in Engine Research Building	2,920
WALLOPS FLIGHT CENTER	2,150
o Rehabilitation of Airfield	
SPACE SHUTTLE AT VARIOUS LOCATIONS	21,405
o Modifications to Solid Rocket Booster Refurbishment and Subassembly Facilities (KSC)	1,700
o Modification of Manufacturing and Final Assembly Facilities for External Tanks (MAF)	17,845
o Minor Shuttle-Unique Projects	1,860
SPACE SHUTTLE PAYLOAD FACILITIES AT VARIOUS LOCATIONS	1,740
o Rehabilitation and Modification for Payload Ground Support Operations	
REPAIR OF FACILITIES NOT IN EXCESS OF $500,000 PER PROJECT	15,000
REHABILITATION AND MODIFICATION OF FACILITIES AT VARIOUS LOCATIONS, NOT IN EXCESS OF $500,000 PER PROJECT	20,000
MINOR CONSTRUCTION OF NEW FACILITIES AND ADDITIONS TO EXISTING FACILITIES AT VARIOUS LOCATIONS, NOT IN EXCESS OF $250,000 PER PROJECT	4,000
FACILITY PLANNING AND DESIGN	8,250
TOTAL CONSTRUCTION OF FACILITIES	100,000

National Aeronautics and Space Administration

RESEARCH AND PROGRAM MANAGEMENT
SUMMARY OF BUDGET PLAN BY INSTALLATION
(millions of dollars)

Installation	FY 1981	FY 1982	FY 1983
Ames Research Center	94.8	102.7	104.9
Goddard Space Flight Center	162.4	170.1	173.6
Headquarters	96.4	110.0	112.6
Johnson Space Center	176.1	186.6	192.4
Kennedy Space Center	150.2	163.4	169.5
Langley Research Center	120.8	128.0	131.3
Lewis Research Center	99.9	107.0	110.6
Marshall Space Flight Center	165.0	170.8	177.7
National Space Technology Laboratories	5.5	6.1	6.3
Total	1,071.1	1,144.7	1,178.9

SUMMARY OF PERMANENT POSITIONS BY INSTALLATIONS

Installation	FY 1981	FY 1982	FY 1983
Ames Research Center	2,058	2,037	2,021
Goddard Space Flight Center	3,699	3,661	3,623
Headquarters	1,506	1,491	1,457
Johnson Space Center	3,380	3,346	3,293
Kennedy Space Center	2,155	2,133	2,112
Langley Research Center	2,895	2,866	2,845
Lewis Research Center	2,690	2,663	2,479
Marshall Space Flight Center	3,385	3,351	3,285
National Space Technology Laboratories	105	104	104
Total	21,873	21,652	21,219

National Aeronautics and Space Administration

FY 1983 BUDGET MULTI-YEAR ESTIMATES
(millions of dollars)

	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987
Space Transportation	3090	3468	3265	2842	2271	2173
Space Science	568	682	681	669	657	641
Space and Terrestrial Applications	334	320	267	272	278	290
Aeronautical Research and Technology	233	232	244	254	264	273
Space Research and Technology	111	123	131	138	145	151
Tracking and Data Acquisition	402	509	635	575	563	563
Total FY 1983 R&D Program	4738	5334	5223	4750	4178	4091
Research and Program Management	1145	1179	1190	1209	1226	1246
Construction of Facilities	98	100	100	100	100	100
Total NASA Program	5981	6613	6513	6059	5504	5437
GNP Deflator in President's Budget	7.9	6.0	5.0	4.7	4.6	4.5
Approximate Equivalent in FY 1983 Dollars			6210	5570	4900	4690

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II. PROGRAM ACTIVITY BY CENTER

National Aeronautics and Space Administration

SUMMARY OF BUDGET PLANS BY INSTALLATION BY APPROPRIATION
(millions of dollars)

	Total			Research and Development			Construction of Facilities			Research and Program Management		
	1981	1982	1983	1981	1982	1983	1981	1982	1983	1981	1982	1983
Johnson Space Center.....	1,702.4	1,807.3	1,809.6	1,523.6	1,616.2	1,613.7	2.7	4.5	3.5	176.1	186.6	192.4
Kennedy Space Center.....	520.9	617.1	626.2	365.1	433.4	451.2	5.6	20.3	5.5	150.2	163.4	169.5
Marshall Space Flight Center.	1,176.2	1,377.6	1,723.5	995.9	1,197.9	1,521.2	15.3	8.9	24.6	165.0	170.8	177.7
National Space Technology Laboratories.....	15.2	17.1	16.2	8.5	9.1	7.6	1.2	1.9	2.3	5.5	6.1	6.3
Goddard Space Flight Center..	741.2	803.4	989.3	571.2	628.4	803.5	7.6	4.9	12.2	162.4	170.1	173.6
Jet Propulsion Laboratory....	268.3	321.5	330.3	258.7	317.1	326.3	9.6	4.4	4.0	---	---	---
Ames Research Center.....	274.3	290.7	282.9	160.4	165.9	167.9	19.1	22.1	10.1	94.8	102.7	104.9
Langley Research Center.....	288.4	256.4	266.7	142.9	122.1	115.5	24.7	6.3	19.9	120.8	128.0	131.3
Lewis Research Center.....	277.4	209.5	205.4	163.5	98.4	87.7	14.0	4.1	7.1	99.9	107.0	110.6
Headquarters.....	240.9	259.5	352.0	144.5	149.5	239.4	---	---	---	96.4	110.0	112.6
Undistributed Construction of Facilities:												
Various Locations.....	7.2	11.3	2.5	---	---	---	7.2	11.3	2.5	---	---	---
Facility Planning and Design.....	10.0	10.0	8.3	---	---	---	10.0	10.0	8.3	---	---	---
Total Budget Plan.....	5,522.4	5,981.4	6,612.9	4,334.3	4,738.0	5,334.0	117.0	98.7	100.0	1,071.1	1,144.7*	1,178.9

* Includes $41,400,000 for increased pay cost

National Aeronautics and Space Administration

FY 1983
MAJOR ACTIVITIES BY CENTER

AMES RESEARCH CENTER/DRYDEN FLIGHT FACILITY

- Aeronautical research and technology
- - Rotorcraft technology, remotely piloted vehicles, computational fluid dynamics
- Aeronautical in-flight testing and research
- Computational fluid dynamics
- Space research and technology
- Life sciences (human-vehicle interaction, biomedical support systems, nonhuman biological experiments)
- Galileo probe project management
- Infrared astronomical satellite telescope instrument
- Shuttle landing site

GODDARD SPACE FLIGHT CENTER/WALLOPS FLIGHT RESEARCH CENTER

- Development of Earth orbital spacecraft for space applications and space science
- Sounding rocket development, procurement, and operations
- Balloon program management
- Aeronautical flight test support (Wallops)
- Experiment management support to environmental observations in weather and climate and ocean dynamics
- Tracking and data acquisition - Tracking Network/Tracking and Data Relay Satellite
- Management of Delta launch vehicle program
- Spacelab payload development and mission management
- Science instruments for Space Telescope and Space Telescope Operations

JET PROPULSION LABORATORY

- Galileo project
- Voyager project
- Infrared Astronomical Satellite project management
- International Solar Polar Mission instruments and support
- Tracking and data acquisition - operation of Deep Space Network
- Network consolidation - Spaceflight Tracking and Data Network and Deep Space Network

JOHNSON SPACE CENTER

- Overall Shuttle management
- Shuttle orbiter development and production of follow-on orbiters
- STS operational planning, flight control for orbital flight test, and crew training
- Interpretive techniques using Landsat data
- Life sciences in-flight experiment development, flight crew monitoring and physiological requirements for manned spacecraft systems
- Advanced concept studies for manned space flight

KENNEDY SPACE CENTER

- o Shuttle launch and landing operations and facilities
- o Shuttle payload integration
- o Spacelab integration and launch
- o Launch of payloads on expendable launch vehicles from both Eastern Space and and Missile Center and Western Space and Missile Center

LANGLEY RESEARCH CENTER

- o Aeronautics research and technology
  - Long haul aircraft, fundamental aerodynamics, fuel efficiency, safety, avionics
- o Space research and technology - structures, materials
- o Environmental observations technology
  - Atmospheric science, experiment development space/ground/aircraft investigation

LEWIS RESEARCH CENTER

- o Aeronautical propulsion research and technology
- o Chemical and electrical propulsion technology and componenet and systems development
- o Management and operation of the Centaur expendable launch vehicle
- o Communications systems technology development

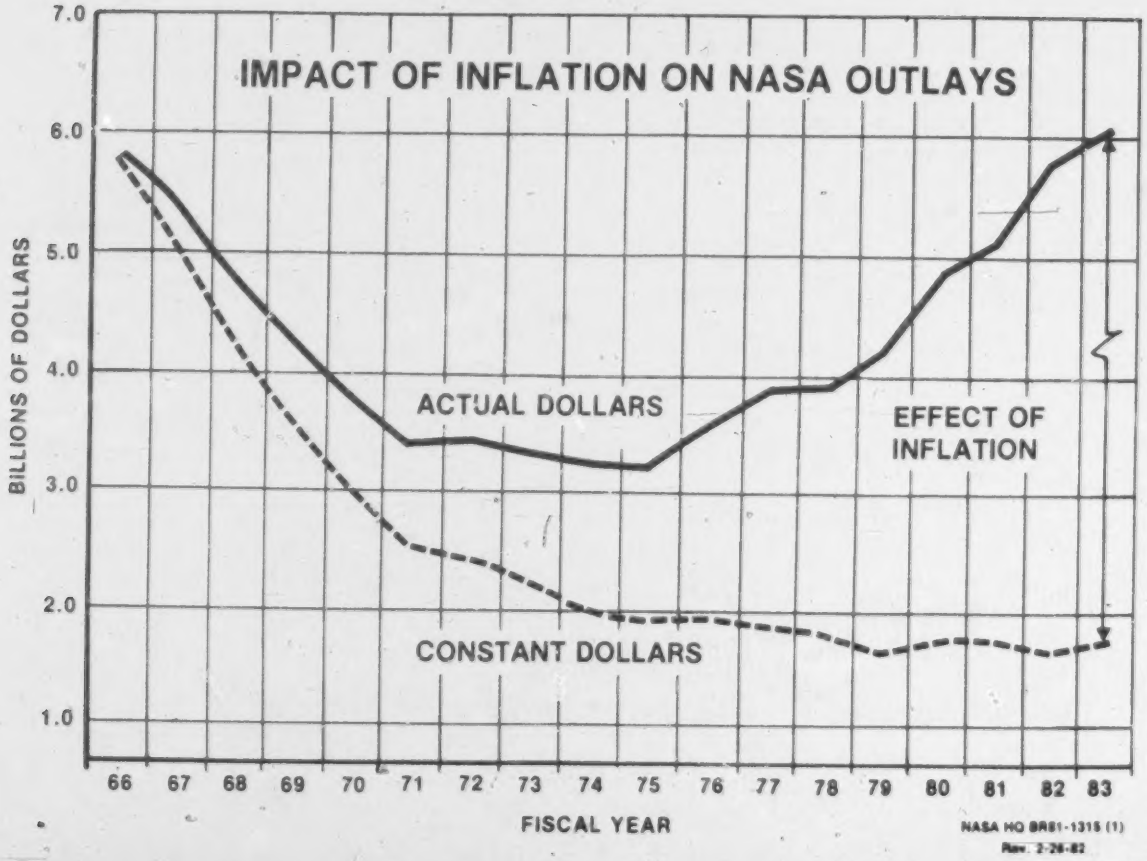
MARSHALL SPACE FLIGHT CENTER

- o Space Shuttle main engine, external tank, solid rocket booster development and procurement
- o Development of NASA elements of Spacelab (crew transfer tunnel, hardware mock-ups, crew trainer, etc.) and procurement of Spacelab hardware from ESA
- o Inertial upper stage support for non-DOD mission
- o Space Telescope project management
- o Materials processing in space research and development
- o Spacelab payload mission management for Spacelabs 1,2, and 3
- o Advanced concept studies for manned space flight

NATIONAL SPACE TECHNOLOGY LABORATORIES

- o Acceptance testing of the Shuttle main engine and main propulsion test article
- o Cryogenic loading tests of the external tanks
- o Remote sensing and environmental research
- o Support of co-located tenant organizations

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



National Aeronautics and Space Administration

IMPACT OF INFLATION
FY 1983 BUDGET
(millions of dollars)

	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	8-Year Permanent Change
TOTAL NASA									
Actual Budget Authority	3,552	3,819	4,064	4,559	5,244	5,523	5,940	6,613	+86%
Inflation Adjustment									
Budget Authority in Terms of Constant FY 1976 Dollars	3,552	3,447	3,404	3,485	3,622	3,441	3,394	3,468	-2%
Based on NASA Index Which Reflects Labor Intensive Nature of NASA Programs		10.8	7.8	9.5	10.7	10.9	9.0	9.0	
Budget Authority in Terms of Constant FY 76 Dollars						3,441	3,433	3,594	+1%
Using GNP Deflator Forcast for FY 1982 and FY 1983							7.9	6.0	

IV. EMPLOYMENT IMPACT AND ECONOMIC BENEFITS OF NASA ACTIVITY

National Aeronautics and Space Administration

EMPLOYMENT TRENDS

	Private Sector Employment	NASA Employed Civil Servants	Total
June 1976	108,000	24,039	132,039
September 1983	107,000	21,219	128,219

- NASA spending is highly labor intensive--approximately 85% of NASA expenditures provides compensation to workers
- NASA employment ranges from low-skill maintenance jobs to highly technical scientific and engineering jobs
- Assuming a multiplier effect of 2.5 - NASA expenditures result in about 320,000 jobs

National Aeronautics and Space Administration

BENEFITS OF NASA PROGRAMS

- Tangible effects on the economy through creation of productive high-technology employment opportunities nationwide

- Intangible benefits realized through exploration of challenging and stimulating new frontiers

- Major contributions to National Security from:
  - Technology advances in high-speed and low-speed aircraft
  - Wind tunnel and flight testing of new aircraft developments
  - Improvements in communications, weather, and remote sensing satellite systems
  - Shuttle capability to launch and retrieve critical payloads

- Practical applications and technology transfer in:
  - Resource observations and identification
  - Environmental observations and monitoring
  - Agricultural crop forecasting
  - Weather observations and forecasting
  - Space and ground support communications systems

- Secondary transfer of aerospace technology:
  - Energy resources and conservation
  - Medicine and life science technology
  - Consumer products - new and improved
  - Construction methodology and techniques
  - Manufacturing processes and materials

- Advances in technology that enhance United States competitive position in worldwide aerospace markets
  - Maintains position of United States as leader in aeronautical technology
  - Reinforces position of United States as leader in electronics
  - Stimulates progress in basic research and in space science and technology

- Promotes and furthers international relations via cooperative missions

- Contributes to the improvement of the national airspace system and aviation safety

V. SUPPLEMENTARY RESEARCH AND DEVELOPMENT

BUDGET DATA

National Aeronautics and Space Administration

AERONAUTICAL RESEARCH AND TECHNOLOGY

- Provide the Nation with the fundamental research and technology in the aeronautical disciplines and speed regimes to:
  - -- Improve performance
  - -- Reduce costs
  - -- Increase safety
  - -- Reduce energy requirements
  - -- Decrease environmental effects
- Accomplish these objectives by means of research and technology efforts in the aeronautical disciplines of:
  - -- Aerodynamics
  - -- Propulsion
  - -- Materials and structures
  - -- Aircraft controls and guidance
  - -- Human factors
- Enhance and validate this disciplinary activity through ground- and flight-based multidisciplinary research and technology in all aeronautical speed regimes and flight modes:
  - -- Low speed
  - -- Subsonic
  - -- Transonic
  - -- Supersonic
  - -- Hypersonic

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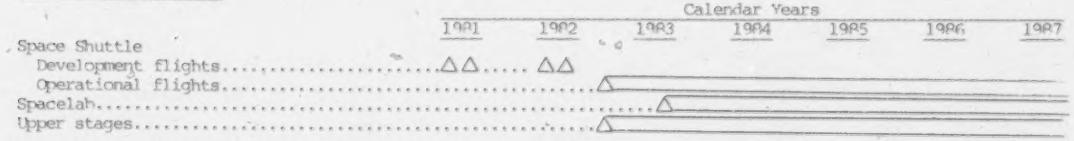
BUDGET PLAN
(millions of dollars)

	FY 1981	FY 1982	FY 1983
Aeronautical Research and Technology.....	271.4	233.0	232.0

SPACE TRANSPORTATION SYSTEMS

- Proceed with development of a versatile space transportation system to provide for:
  - -- Expanded capabilities employing the reusable Space Shuttle system
  - -- Manned orbital experiments using Shuttle and Spacelab
  - -- Deep space and geosynchronous mission capability with upper stages
  - -- Orbital placement, servicing, and retrieval of automated satellites
  - -- Economy in transportation, space operations, and payload costs
- Conclude Shuttle orbital flight tests in FY 1982
- Initiate operational flight missions in early FY 1983
- Continue production to provide a national fleet of Space Shuttle orbiters
- Proceed with development of additional Shuttle performance capability
- Proceed with activities supporting early demonstration of Shuttle on-orbit retrieval and repair capability
- Provide expendable launch vehicle services as required by NASA and other users during transition to the space transportation system

MAJOR FLIGHT ACTIVITY



BUDGET PLAN

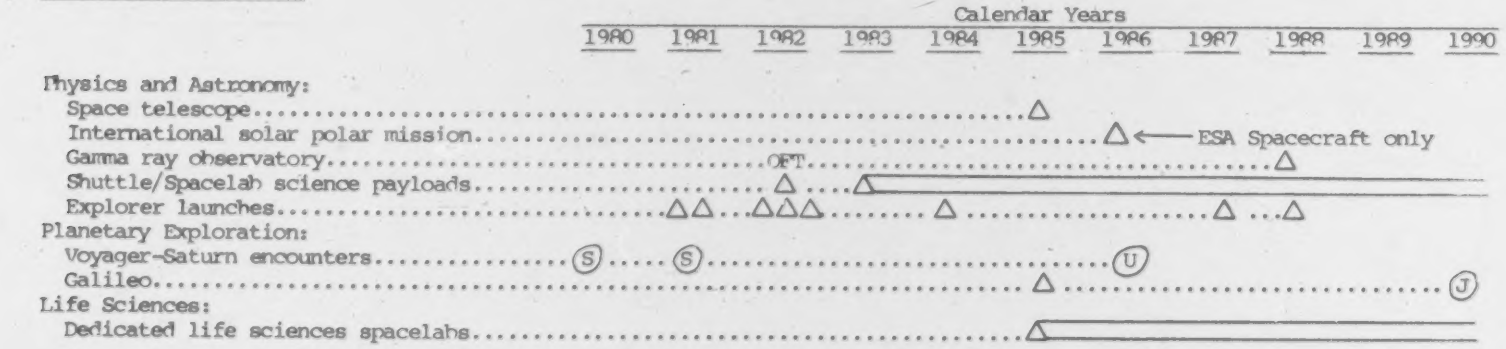
(millions of dollars)	FY 1981	FY 1982	FY 1983
Space Shuttle	1995.0	2163.0	1718.0
Space Flight Operations	679.2	895.9	1707.0
Expendable Launch Vehicles	54.4	31.2	42.8
Total, Space Transportation Systems	2728.6	3090.1	3467.8

National Aeronautics and Space Administration

SPACE SCIENCE

- Increase our understanding of the evolution and nature of the Earth and its environment, the solar system, and the universe through a balanced program of space exploration missions and ground-based investigations
- Exploit the knowledge gained from current and completed program efforts by thorough analysis and interpretation of the scientific data obtained
- Utilize the space environment for research in the biomedical, biological, and bioinstrumentation fields

MAJOR FLIGHT ACTIVITY



BUDGET PLAN
(millions of dollars)

	FY 1981	FY 1982	FY 1983
Physics and Astronomy	323.7	323.5	471.7
Planetary Exploration	175.6	205.0	154.6
Life Sciences	42.2	39.5	55.7
Total, Space Science	541.5	568.0	682.0

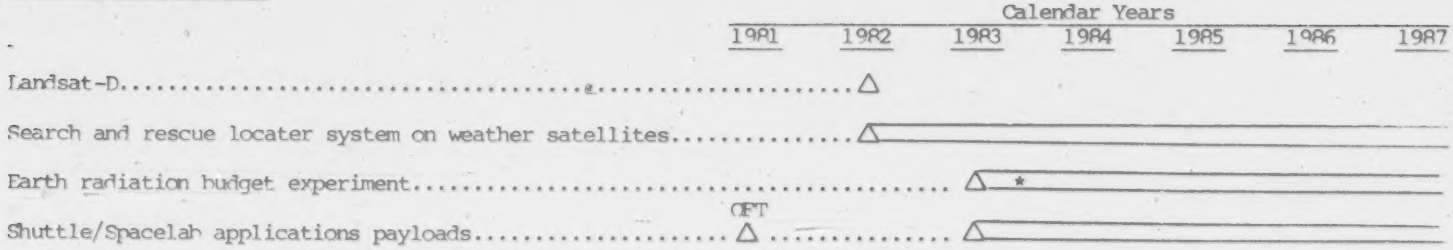
National Aeronautics and Space Administration

SPACE AND TERRESTRIAL APPLICATIONS

o Develop and demonstrate practical uses of space and space-derived technology

-- Remote sensing of Earth resources
-- Environmental observations from space
-- Materials processing in space
-- Space communications

MAJOR FLIGHT ACTIVITY



*currently under review

BUDGET PLAN
(millions of dollars)

	FY 1981	FY 1982	FY 1983
Space Applications	331.5	325.8	316.3
Technology Utilization	8.8	8.0	4.0
Total, Space and Terrestrial Applications	340.3	333.8	320.3

National Aeronautics and Space Administration

SPACE RESEARCH AND TECHNOLOGY

- Provide a technology base essential to future United States leadership in space by:
  - — Improving performance and effectiveness
  - — Reducing cost and risk
  - -- Increasing reliability
  - — Developing technological options
- Achieve these objectives, by means of ground and space-based research and technology activities, through advances in the technology areas of:
  - — Aerotherdynamics
  - -- Materials and structures
  - -- Electronics and automation
  - — Chemical and electric propulsion
  - -- Space power systems
  - -- Component standardization
  - — Spacecraft, transportation, and information systems

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MAJOR FLIGHT ACTIVITY

	Calendar Years						
	1981	1982	1983	1984	1985	1986	1987
Space technology Shuttle/Spacelab payloads				△			

BUDGET PLAN
(millions of dollars)

	FY 1981	FY 1982	FY 1983
Space Research and Technology	110.7	111.0	123.0
Energy Technology	1.9	---	---
Total, Space Research and Technology	112.6	111.0	123.0

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National Aeronautics and Space Administration

TRACKING AND DATA ACQUISITION

- Worldwide networks of ground stations interconnected with highly reliable communications to provide support to:
  - — Shuttle orbital flight tests and operational flights
  - — Automated Earth orbiting missions - approximately fifty applications and scientific spacecraft will be supported including the Nimbus, Landsat-D, International Ultraviolet Explorer, International Sun Earth Explorer, High Energy Astronomy Observatories, Applications Technology Satellites, Solar Maximum Mission, Infrared Astronomical Satellite, Dynamics Explorer, and Solar Mesospheric Explorer
  - — Planetary missions - support will continue for Pioneers-10 and 11 and Voyagers-1 and 2, as well as limited support for Viking, Helios, and earlier Pioneer missions
  - — Sounding rockets
  - — Aeronautical flight research program
- The Tracking and Data Relay Satellite System (TDRSS) will eventually replace most ground stations in providing tracking, command and telemetry services to all low-Earth orbital missions. The first spacecraft will be launched in January 1984 and the second in July 1984.

BUDGET PLAN
(millions of dollars)

	FY 1981	FY 1982	FY 1983
Tracking and Data Acquisition.....	339.9	402.1	508.9

QUESTION B-1:

Mr. Newman, what is the current status of discussion with OMB regarding how you plan to provide for the October pay increase?

ANSWER B-1:

On March 1, 1982, NASA requested OMB to provide supplemental funding for the October pay increase. OMB requested and was provided additional data concerning the supplemental funding request. NASA is now awaiting Administration action.

QUESTION B-2:

What would be the impact on program costs of delaying the Galileo for one year and launching on a long wide-body Centaur?

ANSWER B-2:

If the Galileo mission were delayed until the April/May 1986 window and launched on a direct trajectory to Jupiter using a long wide-bodied Centaur, the net impact on the cost of the Galileo project is estimated at about $100 million. This resulted from the net of reduced operations cost because of the shorter trip time but with additional encounters, elimination of the requirement for a new auxiliary propulsion unit which would be required with an IUS launch, and the additional cost of sustaining the project an extra year before launch. Launch of the Galileo in this window and the International Solar Polar Mission in the same window, however, would require the availability of two orbiters modified for use with Centaur and of two operational launch pads and related equipment to handle the Shuttle with Centaur. The second launch pad is in our present planning but its availability would need to be accelerated to meet the 1986 launch window with resultant funding requirements in FY 1983. Therefore, the net Agency impact in FY 1983 of developing a Centaur to launch Galileo and ISPM in 1986 would be in the $120-150 million range.

QUESTION B-3:

(a) What are the total estimated costs for the filament wound case development?

(b) What degree of confidence do you have in this estimate?

ANSWER B-3:

(a) The total estimated cost for development and for procurement of the first three flight sets of hardware is $225-275 million. This estimate includes the costs of necessary modifications to other systems elements such as the external tank. Approximately $50 million is for procurement of the first three flight sets and the balance for development.

(b) Our confidence in the estimate is good. This estimate is based on NASA studies done both internally and with the contractors

having expertise in this area. As such, it is subject to revision when detailed estimates can be made based on contractor proposal data and further integration analyses.

QUESTION B-4:

What additional amount of funds would be required in FY 1983 to continue operation of the Pioneer spacecraft?

ANSWER B-4:

$6-8 million would be needed in FY 1983 to continue operation of all the Pioneer spacecraft as originally planned.

QUESTION B-5:

If the Agency had an additional $30 million in FY 1983, how would you use it?

ANSWER B-5:

The use of any funding added by the Congress for FY 1983 would depend on several factors. We would have to consider the intent of Congress has expressed in Committee reports, letters, and any attendant legislation; relevant Administration policy; and any problems that surface with regard to the FY 1982 Operating Plan.

QUESTION B-6:

(a) Will funding for procurement of the second Spacelab be completed in FY 1983?

(b) What is the total cost of the second Spacelab?

ANSWER B-6:

(a) Funding for procurement of the second Spacelab will not be completed until FY 1985.

(b) The total cost is $297 million dollars.

QUESTION B-7:

Could you elaborate on the impact of inflation on the NASA budget?

ANSWER B-7:

Inflation has had a dramatic impact on NASA budgets. Since 1976, our budget has increased about 86 percent; but in terms of purchasing power, we have remained essentially at the 1976 level. In terms of a longer horizon, our planned outlays are at approximately the same dollar level as in 1966, but the purchasing power is only about one-third as great. This fact is clearly demonstrated in Chart A which compares actual dollar outlays with constant dollar purchasing power.

QUESTION B-8:

What is your assessment of the impact of NASA spending on inflation? Is NASA spending inflationary?

ANSWER B-8:

NASA spending is assesssed to have no adverse long-run inflationary effects and, in fact, to have positive economic benefits. NASA expenditures are labor intensive, with more than 80 percent of spending directly for jobs and the remainder for materials. NASA employs about 21,000 civil servants and supports about 107,000 contractor employees. Assuming a multiplier effect of 2.5, the total, short-run employment effect on the United States' economy is about 320,000 jobs. This represents less than one-half of one percent of the total civilian labor force in the United States -- too small a number for NASA alone to have a significant national inflationary effect, although there could be some specific cases of industrial and regional employment and price changes influenced by NASA expenditures.

The most significant economic effects of NASA spending are the long-run economic growth from new technologies developed for the space and aeronautics programs. Many NASA-sponsored advances in air and space transportation communications satellites, remote sensing satellites, and other innovations have improved the productive capacity of industry and stimulated the development and growth of many new businesses. These expanded business opportunities have and are expected to continue to stimulate more productive, non-inflationary private sector economic growth and job creation.

Although it is difficult to assess the results of the various macroeconomic studies of the effects of NASA spending on GNP, it is apparent from analyses done by the Midwest Research Institute, Mathematics, Inc., and others, that NASA high technology research and development expenditures have returned more to the economy in substantial and long-lasting productivity gains than has been spent. Therefore, we believe that NASA expenditures are non-inflationary and show positive economic returns in the long-run.

QUESTION B-9:

What was the impact on GRO program costs of delaying the launch from early 1988 until late 1988?

ANSWER B-9:

The Gamma Ray Observatory (GRO) launch has been slipped twice within the last year and we are still in the process of assessing the full impact of these slips. Our preliminary estimate of the cost growth due to the most recent slip is approximately $30 million. This increase is due mainly to the impact of inflation.

QUESTION B-10:

(a) What is the current cost estimate for the Earth Radiation Budget Experiment?

(b) What are the major factors which contributed to this increase?

(c) What confidence do you have in the current estimate?

ANSWER B-10:

(a) The estimated runout range for the Earth Radiation Budget Experiment is $110-130 million which assumes a mid-1984 launch.

(b) This is an increase of approximately $30-35 million over the $80-95 million range given to the Appropriations Committee in March 1980. The $80-95 million range reflected a launch delay of approximately one year due to the FY 1981 Budget Amendment. Subsequently, we have encountered technical problems in the instrument development which has resulted in the higher runout estimate.

(c) NOAA launches are normally on a "call-up" basis; therefore, some uncertainty exists as to exactly when the launch will occur. If the launch is delayed beyond mid-1984, further adjustment in runout cost estimate may be necessary.

QUESTION B-11:

What is the current rate of inflation being experienced in NASA procurements?

ANSWER B-11:

Our last analysis indicated NASA was experiencing approximately 9.0 percent inflation in its procurements which involve highly labor intensive activities.

QUESTION B-12:

In your runout estimates, you use an OMB inflator estimate. What inflation factors does NASA project for 1984-1987?

ANSWER B-12:

NASA activities which are highly labor intensive tend to experience an inflation rate about 2 percent above the GNP deflator rate. Historically, the NASA rates have closely approximated the Bureau of Labor Statistics Compensation Per Hour Index. Our most recent survey indicated that we might expect inflation rates in the 8-9 percent range in the 1984-1987 period. However, the President's program is expected to have the effect of reducing inflation significantly in future years.

Mr. FLIPPO. Mr. Newman, thank you very much.

I wonder if you would tell us the current status of discussions with OMB on how you plan to handle the October pay raise?

Mr. NEWMAN. This past Monday, I believe all agencies submitted to OMB a revised set of material as to what would be involved in meeting that pay raise requirement. We are requesting that those funds be provided by supplemental funding.

Mr. FLIPPO. How much money?

Mr. NEWMAN. The cost of the pay raise as such is $41 million.

Mr. FLIPPO. If you have to absorb that kind of money what is going to be the impact?

Mr. NEWMAN. That depends on the manner in which it is absorbed. Actually, as we see it, it could be a partial absorption, or we could be required to make a total absorption. Under the present appropriation language, we do not have authority to transfer between appropriations. However, I understand there may be a proposal to allow such transfers through legislation.

Mr. FLIPPO. When you say that you hope that the funds will be provided, are you suggesting that OMB might be coming with a supplemental appropriation for that matter, that NASA might be coming with it?

Mr. NEWMAN. That would depend on the OMB decision process, which has really just begun.

Mr. FLIPPO. How much money are we saving by cutting off the Pioneer?

Mr. NEWMAN. Fiscal year 1982 is about the same. I do not have that figure right now.

Mr. FLIPPO. About how much?

Mr. NEWMAN. About $6 million.

Mr. FLIPPO. We had a tremendous increase in operations funding for Space Transportation Systems. Apparently a reduction in what was considered development cost and a significant increase in what is considered operational cost. Do you anticipate that to be level funding for the next few years?

Mr. NEWMAN. No. We anticipate that the total operations funding requirement will grow some from fiscal year 1983 into the future years. Let me clarify. The transfer always has been in the plan. In other words, when we completed the design development test and evaluation effort, it has always been our plan that the operational aspects of the Johnson Space Center in Houston and essentially the entire operation at the Kennedy Space Center would be picked up in the operations program.

Through fiscal year 1982, the people working those functions are concerned mainly with launching and testing the developmental test flights. Beyond that point, their main purpose then becomes preparing and launching the operational flights. There is about 600 million dollars' worth of activity shifted at Kennedy and at Houston in those areas.

Mr. FLIPPO. As I look at your runout cost on space transportation, I see it decreasing after the years 1983 and continuing to decrease through 1987, roughly 1986 and 1987. Therefore, any increased cost in operations you are suggesting will be more than offset by decreased cost in development? Is that essentially what you are saying?

Mr. NEWMAN. Yes, sir, and also in production. Our present projections are that in fiscal year 1983 we have the peak of the funding plan for the present production program. Therefore, there will be a decrease after that in funding requirements for Shuttle production and, of course, we will have completed the funding requirement in fiscal year 1982 for design, development test and evaluation.

Mr. Glickman?

Mr. GLICKMAN. Thank you, Mr. Chairman. I have just a couple questions.

For fiscal 1983 do you anticipate any of your facilities to be closed?

Mr. NEWMAN. We do not have any major facility closings. I worded it that way because there may be some facilities within a center which would be phased down, although I am not specifically aware of any of those.

Mr. GLICKMAN. With respect to your employment, you indicate your civil service positions will remain relatively stable in the aggregate. You drop about 430 individuals.

Mr. NEWMAN. Yes.

Mr. GLICKMAN. Will any of the centers see more significant reductions and others receive significant increases? I am trying to get that broken down a little bit.

Mr. NEWMAN. I believe there are no net increases. If you wish, I can give you a breakdown of that by center.

Mr. GLICKMAN. You could probably supply that to the committee.

[Material to be supplied follows:]

Mr. GLICKMAN. You are saying no center will show net increases?

Mr. NEWMAN. Yes, sir.

Mr. GLICKMAN. There will be decreases, then, in every facility?

Mr. NEWMAN. Every center will have a decrease.

Mr. GLICKMAN. When you say every center, we may not be on the same wave length now. What else might there be then?

Mr. NEWMAN. I am sorry; maybe I am being a little too careful in answering. There may be some specific activities at centers that will increase. But each of the centers, like the Lewis Research Center, the Ames Research Center, the Langley Research Center, or the Kennedy Space Center, will have some decrease in civil service personnel.

Mr. GLICKMAN. I notice that the two major big items on page 3(a), your budget summary, are: (1) space flight operations; and (2) physics and astronomy. Particularly with space flight operations, I am not on the Space Science Subcommittee but I have been concerned for some time to make sure that the Defense Department adequately shares its costs associated with its portion of these flights. I do not think they do that.

Can you give me any idea in fiscal 1983 how much the Defense Department is going to contribute, either if it is reflected in these figures or reflected somewhere else, to the space transportation program?

Mr. NEWMAN. The figures in the space transportation program are the amounts that NASA is requesting direct appropriations for and have already taken into consideration the Department of Defense input. The Department of Defense does reimburse us for Shuttle flights. The agreement that we have for the flights through 1985 is about $16.5 million per flight in 1975 dollars. When you inflate that to the current levels, it is about $36 million.

Mr. GLICKMAN. Really, they are going to reimburse you as though you were a carrier? They are going to pay you for what you carry for them, their instruments and their——

Mr. CAMPBELL. No, they pay for the basic Shuttle flight itself.

Mr. NEWMAN. For the Shuttle's operation. They provide the instruments. All we are talking about here is the transportation that we provide in the standard Shuttle services. Now, they have substantial investments in facilities meeting the security requirements. Of course, they have their investments in the Shuttle facilities and equipment for the Vandenberg Air Force Base launch and landing sites. They have developed the inertial upper stage.

Mr. GLICKMAN. Do you have to reimburse them for your use of their facilities?

Mr. NEWMAN. We do reimburse them when we use certain facilities.

Mr. GLICKMAN. For example, you mentioned Vandenberg.

Mr. CAMPBELL. Under the specific agreement at Vandenberg, there was a quid pro quo involved, where the services at the launch sites were exchanged. However, when we launch out of Kennedy, we reimburse them for certain DOD facilities that we use at Kennedy.

Mr. GLICKMAN. What about at Edwards Air Force Base?

Mr. CAMPBELL. At Edwards there is currently very little reimbursement. It is a cross-servicing agreement where you pretty much match up. We provide them services with no reimbursement, and they provide us services on the same basis. There is some indication that they are about to change that agreement and require us to reimburse them for all direct and indirect costs for support. That is under consideration now.

Mr. GLICKMAN. I have a final question and then I will yield back my time.

If in fact Congress decides to go ahead and fund the Department of Energy programs, which the administration has recommended eliminating at NASA, particularly the Lewis Center, the heat engine programs and related things, how would that affect the civil service position issue? Are those people on your rolls or are they on DOE's rolls?

Mr. CAMPBELL. Yes, they are on our rolls, but they are funded by the Department of Energy.

Mr. NEWMAN. The Department of Energy at present is reimbursing us for the services of people, but they are in our ceilings. Our problem is with the personnel reductions that we have had over the years. It is our position that the Lewis Research Center is the center of excellence in aeronautical propulsion. It is essential that they maintain that leadership in aeronautical propulsion; and, with the level of people we have, they need to focus on that area.

Mr. GLICKMAN. What I am asking is this: What if Congress says we want to keep those automotive programs? What you are telling me is that you have to live within a ceiling. Will the aeronautics programs conceivably have less human beings then?

Mr. NEWMAN. Yes, sir.

Mr. GLICKMAN. How many people are designated to the automotive programs at Lewis?

Mr. NEWMAN. Specifically in automative, I am not sure. In energy, it is 210 people at present.

Mr. GLICKMAN. How many of those 210, if we decided to keep the programs going—and that might depend upon what level we decided to keep them going, too—are those 210 exclusively energy people or are they people who have a hybrid role in both aeronautics and energy?

Mr. NEWMAN. Most of the people are capable of operating in either area. Most of them do in fact. The 210 really is an estimate of the equivalent manyears, not of the head count of people.

Mr. CAMPBELL. It could involve many more people. Like 400 or so working part time.

Mr. GLICKMAN. That is what I thought. You did not use these people exclusively. They might have some aeronautics function, too.

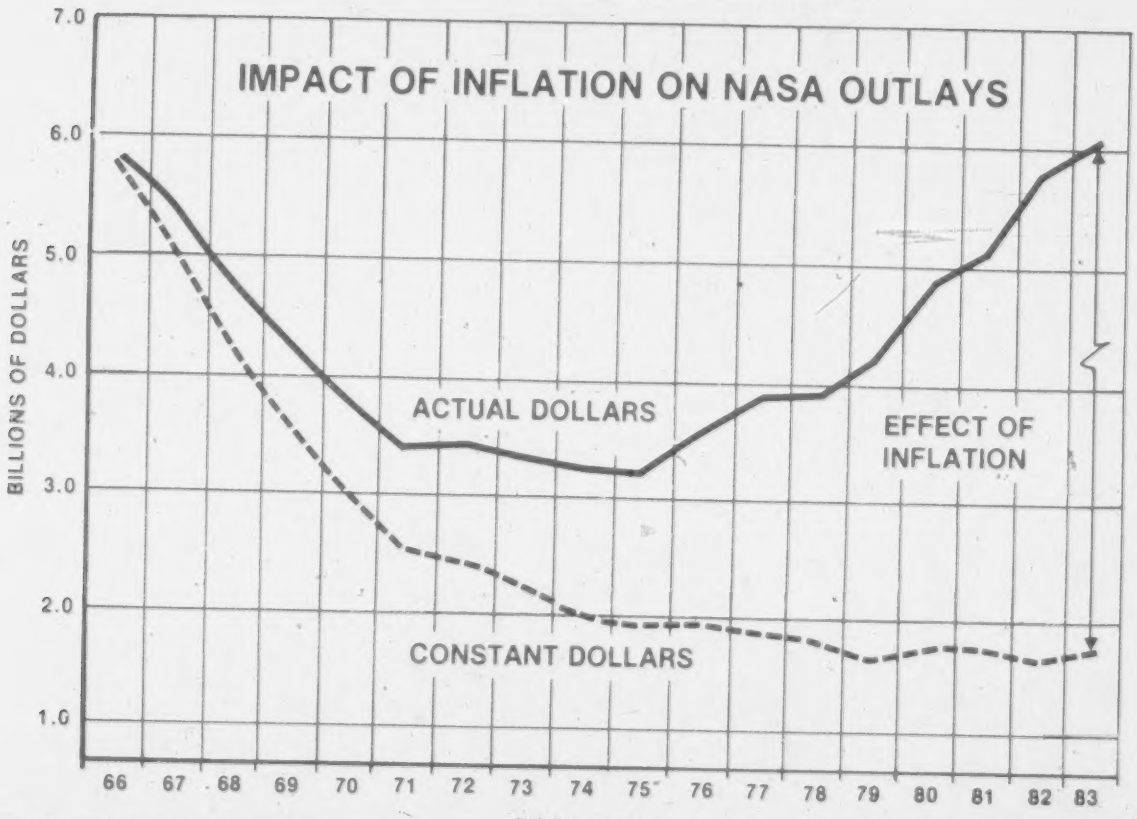
Mr. NEWMAN. Yes, sir.

Mr. GLICKMAN. I view it quite likely that Congress in fact will keep some of the energy programs going. At what level, I am not sure. I would just tell you that right now. Maybe we will talk later about how that will deal with your personnel ceilings.

Thank you, Mr. Chairman.

Mr. FLIPPO. Mr. Newman, thank you very much for your testimony. We appreciate that.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



NASA Inflation Experience Index

Chart A

NASA HQ BR81-1315 (1)
Rev. 2-26-82

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National Aeronautics and Space Administration

TOTAL NUMBER OF PERMANENT POSITIONS
END OF YEAR

Installation	FY 1981	△	FY 1982	△	FY 1983
Johnson Space Center	3,380	-34	3,346	-53	3,293
Kennedy Space Center	2,155	-22	2,133	-21	2,112
Marshall Space Flight Center	3,385	-34	3,351	-66	3,285
National Space Technology Laboratories	105	-1	104	---	104
Goddard Space Flight Center	3,699	-38	3,661	-38	3,623
Ames Research Center	2,058	-21	2,037	-16	2,021
Langley Research Center	2,895	-29	2,866	-21	2,845
Lewis Research Center	2,690	-27	2,663	-184	2,479
Headquarters	1,506	-15	1,491	-34	1,457
Total, Permanent Positions	21,873	-221	21,652	-433	21,219

Next we have Mr. Neil Hosenball, General Counsel of NASA.

Mr. Hosenball, will you please come to the table. Please feel free to proceed as you deem appropriate.

STATEMENT OF S. NEIL HOSENBALL, GENERAL COUNSEL, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. HOSENBALL. Thank you, Mr. Chairman. I do not have a written statement. There are no substantive changes that we have requested this year. The authorization bill basically is the same as you have seen in past years with the amount of authorizations in line items being changed to reflect the 1983 budget.

We do have one piece of legislation which is an administration bill pending before the Ways and Means Committee, which hopefully will be reported out and passed by the Congress, dealing with relieving us from customs duty for importing the RMS under our cooperative program with Canada, and also Spacelab, as well as allowing us to launch foreign satellites without the possibility of import duties, which would probably erode further our competitive position vis-a-vis Ariane. We are hopeful that legislation will go through. It has no impact on budgets inasmuch as it would come out of our program funds and go into the Treasury receipts. It offsets one another, but it does affect our ability to use that money for program activities.

That is all I have to say, Mr. Chairman, unless you have some questions.

Mr. FLIPPO. The report that accompanied the fiscal year 1982 NASA bill requested that the NASA General Counsel look into the indemnification of contractor issues related to the Space Shuttle program. Would you kindly report on the status of that?

Mr. HOSENBALL. Yes, sir. As you know, in the fiscal year 1980 authorization bill we did propose substantive legislation which would permit us to provide insurance or indemnify our users. The Congress did pass that legislation. We had thought it was a potential problem. It gave us the flexibility to meet whatever problems might come up.

Last year in your report, the committee indicated some concern that perhaps we ought to extend that authority in some way to our contractors, a concern that I share in large part. However, I believed it could be solved through an executive branch action, basically an amendment to an existing Executive order. Frankly, your concern was well founded. There have been recent developments where the insurance market is either withdrawing from Shuttle coverage or increasing their premium substantially. Therefore, I think we do have a problem which, hopefully, we will solve.

As a result of the committee's request, I submitted a letter to the Office of Federal Procurement Policy recommending a change to the existing Executive order which would permit us to indemnify our contractors, over and above available insurance at a reasonable price, and would be Government-wide in nature. It would not deal with the whole product liability question where a Government requirement could be impacted. I viewed that proposal not only as a necessary concern of the contractor, but also one of NASA's as well. If, in fact, those premiums do increase, they will go into over-

head. We will be reimbursing; the Government will be paying for those premiums. It could be very expensive in some cases. In addition, I was concerned it might impact our subcontractors and suppliers which usually are much smaller concerns than our major prime contractors. A task group was formed to look at all the aspects of it, including cost, the need, and what has happened in the past. They did recommend to OFPP and to OMB that the Executive order be amended so as to permit us, in particular, to solve our problem. If other agencies had a need for it, they could use it as well.

The OMB has circulated an amended Executive order. They are further awaiting comments of the agencies which were due in on March 1; but, that has been extended to March 7. There are some disagreements among the agencies. I am working, and others are working, to try to resolve those disagreements so that we can get it issued as soon as possible, hopefully before the launch of STS-5, which will have the first commercial payloads aboard.

Mr. FLIPPO. Thank you very much.

Mr. McGrath?

Mr. MCGRATH. Thank you, Mr. Chairman.

On the insurance issue, to what extent are State laws inhibiting the ability for insurance companies to form capital for reinsurance, and in some cases to underwrite some of these launches and other things?

Mr. HOSENBALL. Generally tort law is governed by the State law, both in the Federal courts as well as in the individual State courts. Product liability has gone a long way from where it was when it first became a doctrine as such. Therefore, the insurance companies really have to look at the laws of 50 States and become concerned. The laws in the States vary from State to State. Jury verdicts, as you know, vary from State to State. It is hard to predict what the exposure is.

Mr. MCGRATH. Let me give you an example. In New York State where I come from there are life insurance companies that would like to get into this business of insuring launches, satellites, and whatever, but they are prevented from doing so by State law. Is that commonplace throughout the States?

Mr. HOSENBALL. I think I am somewhat familiar with that. That is a New York unique situation the way I understand it. It is not the products liability law that governs; it is the State insurance law that is the governing factor. I have been told at least that there have been some efforts made in New York State to permit the life insurance companies to go into this area. I think it would be very helpful. As you probably know, most of the Shuttle insurance now is written out of Lloyds of London. I personally would like to see some American underwriters participating more fully in the space program and insuring space risks, particularly if we are going to have commercialization and industrialization in space by our own industry.

Mr. MCGRATH. On another subject, your name appears in a Wilmington, Del., newspaper of January 22 which says that NASA General Counsel, S. Neil Hosenball, instructed the firm—the firm would be Space Transportation Co.—to write a proposal which would fund the fifth Shuttle, so that the Reagan administration

would not have to put it through the Congress and could relinquish control of the shuttle program administratively. Is that true?

Mr. HOSENBALL. No, sir; what was said was depending on the proposal and what they wanted to do—for example, under our act we can make facilities available. That does not need legislation. We can and do make our facilities available. However, the kind of proposal they were thinking about, they were told, would obviously require legislation. Even if we were to make facilities available and not need legislation, we would inform our committees exactly what we were doing so that they would be aware of it. If there was legislation required, we probably would have to go through the normal administration clearance process before it got here. No, that is not an accurate quote. It is quite an inaccurate quote.

Mr. MCGRATH. How about this as an accurate statement——

Mr. HOSENBALL. The other one is going to get me even madder. [Laughter.]

Mr. MCGRATH. One high-ranking NASA official said that the legal office at NASA instructed him not to brief the Administrator and his Deputy on the deal because they have to appear before Congress and we do not want them in a position of having to deny they knew about this.

Mr. HOSENBALL. I am looking for that high-level NASA official. [Laughter.]

I have never done that in my life. It is absolutely untrue. As a matter of fact, I personally called the Administrator's attention to not only that proposal but several others and said that we had to do something with it, that it should be analyzed; that it is not going to go away; and that we ought to take some action. Quite the contrary.

Mr. MCGRATH. Thank you.

Mr. FLIPPO. Thank you, Mr. McGrath.

Mr. Hosenball, the committee appreciates your testimony and your long record of outstanding cooperation with the committee.

Mr. HOSENBALL. Thank you very much, sir.

Mr. FLIPPO. Our next witness is Dr. Walter Olstad, another native of New York. Dr. Olstad, I believe, was educated outside that great State. We are very pleased to have him here today.

Please feel free to submit your statement for the record and summarize as you deem appropriate.

STATEMENT OF DR. WALTER B. OLSTAD, ASSOCIATE ADMINISTRATOR FOR MANAGEMENT, NASA

Dr. OLSTAD. Thank you, Mr. Chairman. I will submit my statement for the record and would like to summarize from it. I will be presenting an overview of NASA's fiscal year 1983 research and program management authorization request. I would like to review some other matters related to the management of the NASA institution.

The research and program management appropriation provides the funding required to maintain the in-house support capabilities necessary to fulfill NASA's R. & D. program responsibilities. About three-fourths of these funds are required to pay the over 21,000 civil servants employed. These highly capable and dedicated scien-

tists, engineers, technicians, and administrators are the core of our capabilities and are essential to the successful execution of our R. & D. programs. These skilled people are our most valuable asset. They represent to the country, to all sectors private or public, a significant portion of this Nation's engineering and technology manpower capability, particularly in fundamental aeronautical and space research and technology and in the management and development of space systems.

The remaining one-fourth of the funds requested provides for the necessary institutional supplies, materials, equipment, utilities, services, and travel to support our staff and operate our centers. As you will recall, NASA in 1981 initiated two major organizational changes designed to improve the efficiency and effectiveness of our institutional operation to assure proper delegation of authority to all line managers, to set forth a clear distinction between line and staff, and to simplify and clarify field centers reporting lines.

The chief institutional change was to place each center under the managerial control of that program associate administrator who has major programmatic responsibility at that center. At the same time, the Office of Management was created from NASA's old Office of Management Operations and the Supply and Equipment and Facilities Divisions from the Comptroller's organization. This new Office of Management will concentrate on assuring that the overall management support to the line program offices is efficient and effective. We hope that this revised management structure will allow us to manage our programs, installations, and administrative responsibilities effectively within the resources levels available to NASA.

Before I address NASA's budget request for fiscal year 1983, I would like to discuss with you the changes from the original fiscal year 1982 budget plan which was presented to you last year. As you know, NASA, along with other executive agencies, reduced its operations level in fiscal year 1981 and 1982 as a result of the President's budget amendment in March 1981. That amendment reduced the NASA's 1982 permanent civil service ceiling by 840 to a level of 21,873, and the reduction was to be accomplished by the end of fiscal year 1981. The concomitant reduction in research and program management funds in fiscal year 1982 was $22 million—$20.7 million in personnel and related costs and $1.3 million in travel.

Last fall NASA permanent civil service was further reduced by 221, bringing the total reducton to 1,061 from the fiscal year 1982 budget plan originally presented to the Congress. In order to accomplish this further reduction, we will be continuing to rely in large part on attrition, but may be compelled to resort to reduction-in-force procedures to realize selected areas to avoid unacceptable skill imbalances.

The current estimate for fiscal year 1982 research and program management is $1,144.7 million, an increase of $30.4 million above the amount appropriated. All of this increase is in personnel and related costs, and results from the $41.4 million needed to cover the calendar year 1981 pay raises, less the $11 million reduction we sustained as a result of the application of section 501(41) of the HUD-Independent Offices Appropriation Act (Public Law 97-101).

The financing of the increased salary rates as part of the fiscal year 1982 research and program management budget plan is still under the consideration by the Office of Management and Budget.

We hope that the request for these necessary additional funds will be forthcoming and that personnel reductions, over and above those that I have already mentioned, will not be required. The request for fiscal year 1983 is $1,178.9 million, an increase of $34.2 million over the current fiscal year 1982 plan. The request covers the full-year cost of 21,219 permanent civil servants, a further reduction of 433 from the current fiscal year 1982 plan; the minimum level of travel required to support Agency missions; anticipated price levels in support service contracts, with no increase in effort provided; utilities at anticipated rates with a small reduction in consumption; and a constant level of supplies, materials, equipment, and other support at anticipated price levels.

By the end of fiscal year 1983, NASA will have reduced its civil service work force by almost 1,500 from the level initially presented for fiscal year 1982, and we will be at our lowest complement in over 20 years. We believe that we can achieve these reductions in a manner which will minimize detrimental impacts upon NASA's capabilities, programs, and upon the individuals involved. The fiscal year 1983 estimate for personnel and related costs is based upon full-year funding of $829.9 million for NASA's permanent, full-time staff.

The funding request for travel of $24.1 million is the same as NASA's current fiscal year 1982 estimate in response to a Government-wide policy for travel to be at the fiscal year 1982 level in fiscal year 1983. This budget will support a level of travel by civil service personnel 6 percent lower than in fiscal year 1982, at anticipated transportation and per diem rates.

The fiscal year 1983 plan for operation of installation at $324.9 million provides about the same level of support for the operations of the various NASA centers as in the current fiscal year 1982 plan.

As we have noted, for the past several years increasing utility costs are a matter of serious concern. NASA has a continuing conservation program which by the end of fiscal year 1983 should result in our maintaining a 40-percent reduction in utilities energy usage from fiscal year 1973. Nevertheless, the unit cost of energy continues to grow much faster than can be offset by this stringent program of conservation efforts.

I will now highlight other institutional items which may be of interest to you.

In October 1981, NASA implemented merit pay for 2,894 GS–13 through GS–15 managers and supervisors. Because of the last-minute changes necessitated by the Comptroller's general decision, some morale problems were caused among those converted. We are working with the Office of Personnel Management and our centers to ameliorate these morale problems.

On a more positive side, NASA continued to make modest progress in the area of equal opportunity during fiscal year 1981. The actual number of minority employees fell by 22 to 2,472, due to overall reductions in complement. However, their percent of the work force rose from 11 to 11.3 percent. Minorities in professional

positions on the other hand rose by 28 to 1,218. Within these professional positions, minorities increased from 11.2 to 11.6 percent in administrative positions and from 7.1 to 7.4 percent in scientific and engineering positions. Similarly with women, total employment declined by 101 to 4,711, but their percentage of the work force increased from 21.3 percent to 21.6. During the year, the number of women in professional positions in fiscal year 1981 increased by 77 to 1,673. Minorities and women continued to move into positions of greater responsibility and increased to 144 and 140 in management and supervisory positions, respectively. This represented an increase from 4.2 to 4.4 percent for minorities and 4.1 to 4.3 percent for women.

For the past several years, we have discussed our implementation of the Civil Service Reform Act. As you know, the Presidential rank awards for senior executives are part of that act. The awards to NASA people in the first 2 years of the program, 8 distinguished and 34 meritorious ranks, are an indication of the degree to which NASA remains at the forefront of the Nation's effort to maintain its technological excellence.

Mr. Chairman, that concludes my remarks.

[The prepared statement of Dr. Olstad follows:]

93-418 O—82——83

March 4, 1982

Mr. Chairman and Members of the Subcommittees:

It is my pleasure to present for you today an overview of NASA's FY 1983 Research and Program Management Authorization request, and to review other matters related to the management of the NASA institution.

The Research and Program Management appropriation provides the funding required to maintain the in-house support capability necessary to fulfill NASA'S R&D program responsibilities. About three-fourths of these funds are required to pay the over 21,000 civil servants employed. These highly capable and dedicated scientists, engineers, technicians and administrators are the core of our capabilities and are essential to the successful execution of our R&D programs. These skilled people are our most valuable asset. They represent to the country, to all sectors private or public, a significant portion of this Nation's engineering and technology manpower capability, particularly in fundamental aeronautical and space research and technology, and in the management and development of space systems. The remaining one-fourth of the funds requested provide for the necessary institutional supplies, materials, equipment, utilities, services and travel to support our staff and operate our Centers.

As you will recall, NASA, in 1981, initiated two major organizational changes designed to improve the efficiency and effectiveness of our institutional operations. Last spring, Dryden Flight Center was made a part of the Ames Research Center, and the Wallops Flight Center part of the Goddard Space Flight Center. These actions were taken to focus the resources of each installation upon what each can do best. The close relationship between Ames' and Dryden's efforts in aeronautical programs, and Wallops' and Goddard's efforts in suborbital programs, as well as the unique facility capabilities and the physical proximity of the installations, provided an opportunity to improve overall program effectiveness through these consolidations.

As you know, a change was also made at NASA Headquarters to assure proper delegation of authority to all line managers, to set forth a clear distinction between line and staff, and to simplify and clarify field Centers' reporting lines. The chief institutional change was to place each Center under the managerial control of that Program Associate Administrator who has major programmatic responsibility at that Center. NASA's Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center and National Space Technology Laboratories report to the Associate Administrator for Space Transportation Systems; NASA's Ames Research Center, Langley Research Center and Lewis Research Center to the Associate Administrator for Aeronautics and Space Technology; and NASA's Goddard Space Flight Center (as well as the Jet Propulsion

Laboratory) to the Associate Administrator for Space Science and Applications.

At the same time my Office, the Office of Management, was created from NASA's old Office of Management Operations, and the Supply and Equipment and Facilities Divisions from the Comptroller's organization. This new Office of Management will concentrate on assuring that the overall management support to the line Program Offices is efficient and effective. We hope that this revised managment structure will allow us to manage our programs, installations and administrative responsibilities effectively within the resources levels available to NASA.

Before I address NASA's Budget request for FY 1983 I would like to discuss with you the changes from the original FY 1982 Budget plan which was presented to you last year. As you know NASA, along with other executive agencies, reduced its operations level in FY 1981 and 1982 as a result of the President's Budget Amendment in March, 1981. That Amendment reduced the NASA's 1982 permanent civil service ceiling by 840 to 21,873, and the reduction was to be accomplished by the end of FY 1981. The concomitant reduction in Research and Program Management funds in FY 1982 was $22.0 million--$20.7 million in Personnel and Related Costs and $1.3 million in Travel. Last fall NASA permanent civil service was further reduced by 221, bringing to 1,061 the total reduction from the FY 1982 Budget plan originally presented to Congress. In order to accomplish this further reduction, we will be continuing to rely in large part on attrition, but may be compelled to resort to Reduction in Force procedures to realign selected areas to avoid unacceptable skill imbalances.

The current estimate for FY 1982 Research and Program Management is $1,144.7 million, an increase of $30.4 million above the amount appropriated. All of this increase is in Personnel and Related Costs, and results from the $41.4 million needed to cover the calendar year 1981 pay raises, less the $11.0 million reduction we sustained as a result of the application of Section 501(41) of the HUD-Independent Offices Appropriation Act (PL 97-101). The financing of the increased salary rates as part of FY 1982 Research and Program Management Budget plan is still under consideration by the Office of Management and Budget. We hope that a request for these necessary additional funds will be forthcoming and that personnel reductions, over and above those I have already mentioned, will not be required.

FY 1983 ESTIMATE

The request for FY 1983 is $1,178.9 million, an increase of $34.2 million over the current FY 1982 plan. The request covers the full-year cost of 21,219 permanent civil servants, a further reduction of 433 from the current FY 1982 plan; the minimum level

of travel required to support Agency missions; anticipated price levels in support service contracts, with no increase in effort provided; utilities at anticipated rates with a small reduction in consumption; and a constant level of supplies, materials, equipment and other support at anticipated price levels.

By the end of FY 1983, NASA will have reduced its civil service work force by almost 1,500 from the level initially presented for FY 1982, and we will be at our lowest complement in over 20 years. We believe that we can achieve these reductions in a manner which will minimize detrimental impacts--both upon NASA's capabilities and programs, and upon the individuals involved.

NASA's FY 1983 Research and Program Management Budget request of $1,178,900,000, by functional category, is summarized as follows:

1. Personnel and Related Costs: $829,900,000

The FY 1983 estimate for Personnel and Related Costs is based upon full-year funding for NASA's permanent, full-time staff. The decrease in funding of $134,000 from the current FY 1982 estimate results from the further decline in the permanent civil service staff (-433), the full-year effect of FY 1982 changes, and the net effect of within grade and career advances and turnover savings.

2. Travel: $24,100,000

The funding request for Travel is the same as NASA's current FY 1982 estimate in response to a Government-wide policy for travel to be at the FY 1982 level in FY 1983. This budget will support a level of travel by civil service personnel 6% lower than FY 1982, at anticipated transportation and per diem rates.

3. Operation of Installation: $324,900,000

The FY 1983 plan, at anticipated FY 1983 price levels, provides about the same level of support to the operations of the various NASA Centers as in the current FY 1982 plan. The amounts by sub-category are as follows:

A. Facilities Services--$179,881,000: The FY 1983 estimate, an increase of $23,732,000 over the FY 1982 current plan, reflects anticipated support contractor and utility rate increases; a small reduction in energy consumption; and supplies, materials, equipment and other contracts at anticipated FY 1983 price levels. About 80% of these funds are associated with utilities, custodial support, security, fire protection and rental costs. These elements continue the level of services provided in FY 1982, and are essential areas to the operation of NASA's laboratories and research

facilities. Supported by this funding are some of the more advanced facilities in the world that perform a key role leading to future developments in both military and commercial aviation and space transportation systems. The balance of the Facilities Service funding will help maintain and repair the Nation's $7 billion facilities and equipment capital investment at our laboratories.

B. Technical Services--$55,526,000: The $3,473,000 increase in FY 1983 covers anticipated contractor rate increases, as well as increased costs of supplies, materials and equipment in this sub-category.

C. Management and Operations--$89,493,000: This sub-functional category includes a variety of services such as management support, communications, general on-site transportation (including payments to inter-agency motor pools), administrative aircraft operations, medical services, printing and reproduction, mail services, administrative supplies and equipment, postage, and other installation support services. These funds provide the basic level of administrative support that our research and development people require in the performance of their work. The $7,129,000 increase in this sub-category is needed to provide for the increased costs of supplies, materials and equipment, and the anticipated escalation in support contractor rates.

We feel our FY 1983 R & PM request is lean. The increased funding, partially offset by the further reduction in civil service personnel, is requested only to cover the full year effect of civil service pay increases; the higher costs associated with increasing utility and support service contractor rates; and the higher price levels for communication, transportation, and administrative supplies, materials and equipment. As we have noted for the past several years, increasing utility costs are a matter of serious concern. NASA has a continuing conservation program which, by the end of FY 1983, should result in our maintaining a 40% reduction in utilities energy usage from FY 1973. Nevertheless, the unit cost of energy continues to grow much faster than can be offset by this stringent program of conservation efforts.

This concludes my statement on the Research and Program Management Budget. I will now highlight other institutional items which may be of interest to you.

In October, 1981, NASA implemented "Merit Pay" for 2,894 GS-13/15 managers and supervisors. Because of the last minute changes necessitated by the Comptroller General's decision, some morale

problems were caused among those converted. We are working with the OPM and our Centers to ameliorate these morale problems.

On a more positive side, NASA continued to make modest progress in the area of equal opportunity during FY 1981. The actual number of minority employees fell by 22 to 2,472 due to overall reductions in complement; however, their percent of the work force rose from 11.0% to 11.3%. Minorities in professional positions, on the other hand, rose by 28 to 1,218. Within these professional positions, minorities increased from 11.2% to 11.6% in administrative positions and from 7.1% to 7.4% in scientific and engineering positions. Similarly with women, total employment declined by 101 to 4,711, but their percent of the work force increased from 21.3% to 21.6%. During the year, the number of women in professional positions in FY 1981 increased by 77 to 1,673. Within these professional positions, women increased from 28.8% to 30.8% in administrative occupations, and 5.2% to 5.5% in scientific and engineering positions. Minorities and women continued to move into positions of greater responsibility, and increased to 144 and 140 in management and supervisory positions respectively. This represented an increase from 4.2% to 4.4% for minorities and from 4.1% to 4.3% for women.

As of September 30, 1981, handicapped employees comprised 1,344 or 5.6% of NASA's work force. There were 150 or 0.6% with severe or targeted disabilities, and 630 or 2.6% disabled veterans.

Our program in equal opportunity has been successful because it receives the attention and support of senior management at Headquarters and our field centers. In FY 1982 and 1983 we expect to continue to make gains in achieving our goal of a representative NASA work force, even though there will be further civil service personnel reductions.

For the past several years we have discussed our implementation of the Civil Service Reform Act. As you know, the Presidential Rank awards for senior executives are part of that Act. The awards to NASA people in the first two years of the program, 8 Distinguished and 34 Meritorious Ranks, are an indication of the degree to which NASA remains at the forefront of the Nation's effort to maintain its technological excellence.

Mr. Chairman, that concludes my prepared remarks. I will be happy to answer any questions you or Members of the Subcommittees may have.

Mr. FLIPPO. Thank you very much, Doctor.

You did mention major organizational changes during the year. Does a program manager normally issue contracts for services and procurement? Do most of the contracts go through the program manager?

Dr. OLSTAD. The program managers and project managers, of course, are the initiating agents for contracts. They go through the usual procurement officers and all of the other checkpoints, but the project managers and program managers are the ones who make the major decisions.

Mr. FLIPPO. Is there any trend? Is there an increasing number of contracts with headquarters rather than with field centers?

Dr. OLSTAD. I am not aware of any trend. Most of our contracts come out through the project managers at the centers.

Mr. FLIPPO. But there are exceptions to that rule?

Dr. OLSTAD. There are exceptions in the area of grants to universities in the space sciences area, for example. But, I am not aware of any in terms of major contracts.

Mr. FLIPPO. Support contracts.

Dr. OLSTAD. There are some support service contractors that support headquarters operations, and those are initiated at headquarters. However, for the support of operations at centers, those almost without exception, as far as I am aware, come from those centers.

Mr. FLIPPO. The Civil Service Reform Act, the merit pay provisions, could you perhaps provide us something in writing regarding NASA's experience with it. Perhaps you would provide us some suggestions as to how either to fix it or, if it is not fixable, perhaps is it in the best interest of the Nation and might let you sleep better at night if you did not have it?

Dr. OLSTAD. I would be very happy to provide you with such a response. I would like to say that I think the concept is a very good one and that we like very much the idea of providing incentive awards for employees. The biggest problem we face is a lack of funds to do that. In fact, it has turned into a disincentive. The major problem with that program now is a lack of funds to provide the incentives. If those funds cannot be made available, we may well like to back away from that program. I think it can have some very positive effects.

[The information follows:]

NASA's experience with the merit pay system has been a great disappointment to Agency management. We believe the results have been directly contrary to the objectives of the Congress in establishing this system to provide incentives which would motivate high quality performance among supervisors and managers.

In October 1981, NASA converted 2894 managers and supervisors in grades GS–13 to GS–15 to the merit pay system. Last minute changes to the merit pay pool ordered by the Comptroller General and Office of Personnel Management (OPM) reduced the funds available for merit pay by 50–60 percent. Our first payout resulted in many merit pay employees receiving significantly lower rates of pay than employees at the same grades who were not under merit pay. The average merit pay increase during this first year was $381 or an increase of approximately 0.9 percent of salary. This has caused a significant disillusionment among the middle managers covered by merit pay. The system as it now exists demotivates high performers to move into jobs as supervisors or managers.

The results of this system are particularly destructive in organizations with research and development missions. Such organizations typically have parallel career ladders which enable scientists and engineers to reach grades GS–13, GS–14, and

GS–15 through their individual accomplishments as well as through the managerial ranks.

Two-thirds of our employees at the GS–13/15 grade levels are not managers or supervisors and thus not covered by merit pay. The one-third of our employees at these grades who are managers or supervisors possess the unusual combination of technical expertise and managerial ability which has been a major strength of this Agency. It is unacceptable to us to administer a pay system that provides lower rates of pay for this important group than the pay that is received by those they supervise.

While every effort was made within NASA to minimize the adverse consequences of this system, most of the key factors were beyond the Agency's control.

In order to spur action to improve the system, our Administrator, Mr. Beggs has sent a letter to the Director of the Office of Personnel Management (OPM), Dr. Devine. We suggest an immediate constructive effort by OPM to remove the inequities caused by having two incompatible pay systems (General Schedule and Merit Pay) affecting employees at the same grades, either through legislative action or administrative remedy.

We have proposed the following thoughts for consideration: Exclude R. & D. organizations from merit pay while a review is made; explore the application of Navy's China Lake demonstration project to scientists and engineers Government-wide; allow more discretion for agencies to determine the ratios of pay increases at varying levels of performance; broaden merit pay coverage to all employees at grades GS–13/15; shift the pay range for managers and supervisors upward by 6–10 percent; and increase funds making up the merit pay pools.

Mr. FLIPPO. Can you accommodate the fiscal years 1982 and 1983 reductions without a RIF?

Dr. OLSTAD. We believe that we will be able to do that. However, one cannot always predict what attrition will be. Because of the reductions in manpower that we have experienced over several years, mostly through attrition, we do have some potential skill problems. There is a possibility that we may have to do some selective reductions in force, but our goal is to try to avoid that if we can.

Mr. FLIPPO. Mr. McGrath?

Mr. MCGRATH. Thank you, Mr. Chairman.

Just as a personal note, I read the biographies just to know about our witnesses. I note that you come from Greenport, which is on Long Island. I used to vacation at Peconic and work out there, as a matter of fact.

You obviously are a well-qualified scientist. What are you doing in management? [Laughter.]

Dr. OLSTAD. That is a question I have asked myself. [Laughter.]

I am not sure I could articulate the full answer to that one yet. This is a technical agency. All aspects of what we do relate to the technical product that we put out. I feel that I can continue to make a contribution toward that. I feel that my experience helps me understand what the customer of the service that management provides really wants. I think that is also what the Administrator and Deputy Administrator feel as well, because they have told me that. They want me to make sure that the customer of the service that management provides is satisfied and is able to do the technical job at the highest productivity level.

Mr. MCGRATH. Last year you had a reduction of about $11 million caused by the Appropriations Act general reduction. How are you going to absorb that?

Dr. OLSTAD. The $11 million is to be absorbed by the reduction of 221 people or man-years in fiscal year 1982.

Mr. MCGRATH. So you did have to lay some employees off last year?

Dr. OLSTAD. Yes; we have had a number of manpower reductions which is a total from our original request to the Congress for fiscal year 1982 of some 1,061. That total includes the 221 further reduction that we received in the fall. That equates to the $11 million.

Mr. MCGRATH. Out of what areas did they come?

Dr. OLSTAD. Quite a few areas. I can give you that in detail for the record.

Mr. MCGRATH. That will be fine.

[Material to be supplied follows:]

NASA has altered center ceilings in fiscal year 1982 from the budget originally presented to the current plan and in fiscal year 1983 from fiscal year 1982 related to program changes. The major changes by centers are as follows:

JOHNSON SPACE CENTER

Fiscal year 1982:	
Overall change	−143
Major programs affected:	
Space transportation systems	−61
Space applications	−88
Fiscal year 1983:	
Overall change	−53
Major program affected: Space transportation systems	−47

KENNEDY SPACE CENTER

Fiscal year 1982:	
Overall change	−68
Major programs affected:	
Space transportation systems	−124
Physics and Astronomy [1]	+71
Fiscal year 1983:	
Overall change	−21
Major program affected: Space transportation systems	−23

MARSHALL SPACE FLIGHT CENTER

Fiscal year 1982:	
Overall change	−210
Major programs affected:	
Space transportation systems	−92
Physics and Astronomy (Spacelab)	+118
Space applications	−73
Energy technology	−125
Support positions	−35
Fiscal year 1983:	
Overall change	−66
Major programs affected:	
Space transportation systems	−106
Physics and Astronomy	+27

GODDARD SPACE FLIGHT CENTER

Fiscal year 1982:	
Overall change	−178
Major programs affected:	
Space applications	−88
Support positions	−99
Fiscal year 1983:	
Overall change	−38
Major program affected: Space applications	−51

AMES RESEARCH CENTER

Fiscal year 1982:	
Overall change	−82
Major programs affected:	
Physics and Astronomy	−20

Space applications	−18
Support positions	−50
Fiscal year 1983:	
Overall change	−16
Major program affected: Space Shuttle support	−15

LANGLEY RESEARCH CENTER

Fiscal year 1982:	
Overall change	−114
Major programs affected:	
Space applications	−15
Aeronautics	−91
Space reserach and technology	−14
Fiscal year 1983:	
Overall change	−21
Major programs affected:	
Space Shuttle support	−7
Support positions	−10

LEWIS RESEARCH CENTER

Fiscal year 1982:	
Overall change	−172
Major programs affected:	
Space applications	−71
Expendable launch vehicles	+64
Energy technology	−188
Fiscal year 1983:	
Overall change	−184
Major programs affected:	
Energy technology	−162
Support positions	−34

NASA HEADQUARTERS

Fiscal year 1982:	
Overall change	−95
Major program affected: Support positions	−85
Fiscal year 1983:	
Overall change	−34
Major program affected: Energy technology	−18

SUMMARY, NASA TOTAL

Fiscal year 1982:	
Overall change	−1,061
Fiscal year 1982 budget amendment	−840
Fiscal year 1983 budget decisions	−221
Fiscal year 1983: Overall change	−433

[1] The increase results from reclassification of Spacelab missions from STS to P&A.

Dr. OLSTAD. It is spread across quite a few areas.

Mr. MCGRATH. I have no further questions.

Mr. FLIPPO. For every employee you had to RIF, what is the impact on NASA? How many others get moved around? What are the problems which are created? You are not really just talking about 200-and-something people, although that is bad enough. There is an impact on the agency.

Dr. OLSTAD. Our experience shows, and we estimate, that for every employee involved in an initial reduction-in-force action where their position is abolished that some four or five other actions follow in terms of bumping or moving people into other positions. That does not always end up with someone losing a job, but it can end up with people moving to lower grades.

Mr. FLIPPO. Thank you very much for your testimony. We appreciate it.

Our next witness is Maj. Gen. Billie McGarvey. He was appointed Director of Facilities in 1978. He is a native of Texas. He has been before the committee many times.

We are pleased to have you. Please feel free to summarize and proceed as you deem appropriate.

STATEMENT OF MAJ. GEN. BILLIE J. McGARVEY, DIRECTOR OF FACILITIES, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

General McGARVEY. Thank you, Mr. Chairman. I do have a brief statement which I will briefly summarize and submit the full statement for the record.

Mr. Chairman, I appreciate this opportunity to appear before you today to present the NASA fiscal year 1983 construction of facilities budget request. Our budget request totals $100 million as compared to $104.8 million requested in fiscal year 1982 and $98.7 million that is currently available for fiscal year 1982. Although the program is not large, it is an extremely essential program that provides the contractual services for necessary repairs, rehabilitation and modification of existing facilities, construction of new facilities, acquisition of related facility equipment, and the planning and design of facility projects which support the research, development, and testing activities of the Agency.

The present NASA physical plant represents capital investments of over $7 billion and a replacement value of more than $20 billion. This physical plant is comprised of unique aerospace research, development, test and operational facilities and equipment. Our fiscal year 1983 construction budget request has been structured to meet our continuing objective of preserving and enhancing the capabilities and usefulness of this physical plant. The proposed program is a very lean but balanced response to requirements which exceed the funding limitations dictated by today's economic environment. The request is a program made up of only our highest priority needs. In highlighting the salient features of the budget request, I will briefly discuss several of the large, discrete projects and then summarize the minor program and planning and design activities.

Prior to addressing the details of the current request, I would like to highlight some selected projects that have been high interest items to this subcommittee in earlier budgets. The two large aeronautical facility projects costing $85 million each are now nearing completion of construction. The national transdonic facility at Langley is approximately 95 percent complete and should be completed in July 1982, leading to full operations by the end of this calendar year.

Likewise, the modifications of the 40-by 80 subsonic wind tunnel at Ames Research Center is proceeding satisfactorily. The overall construction is approximately 90 percent complete with the repowering of the 40- by 80-foot tunnel circuit 95 percent complete at this time, and the new 80- by 120-foot test leg addition 80 percent complete. Construction should be completed in mid-1982, and the facility should become operational in the late 1982 timeframe. Both of these projects have been significant challenges in terms of technical design requirements and construction management. Barring

any unforeseen major problems, we anticipate that future updates to you on these two facilities will be in terms of research being accomplished and the results achieved.

A second item of continuing interest pertains to the Shuttle launch facilities at Kennedy. The facilities supporting the first two launches have performed flawlessly and have suffered very little damage from the launches. We are particularly pleased that repair or renovation of launch facilities have not been pacing items affecting the turnaround activities between the Shuttle flights.

A final update item is the status of our energy conservation program. As you will recall, NASA established a goal of reducing the consumption of utilities energy by 50 percent by fiscal year 1985 as compared to fiscal year 1973 baseline. This goal has provided the incentive for developing energy retrofit projects and improving facility operations. A 40-percent overall reduction that was reached last year was sustained in fiscal year 1981 despite increased energy requirements for Space Shuttle operations. Our current assessment is that we will probably achieve closer to a 45-percent reduction by fiscal year 1985 than the 50-percent prediction. However, we are continuing to seek further reductions and improvements where feasible.

We are requesting $23,145,000 for the Space Shuttle and payload facilities with the major projects located at the Kennedy Space Center and the Michoud assembly facility. The modifications of solid rocket booster refurbishment and subassembly facilities at Kennedy, estimated to cost $1,700,000, are required to support the flight rates projected for fiscal year 1984 and subsequent years. Experience with the first two Shuttle flights and related SRB studies have shown that additional capabilities for refurbishing and assembling forward an aft skirts, frustrums, and nose cones are required to support future flight rates. The principal thrust of this project is the relocation of forward assembly buildup areas within the low bay of the vehicle assembly building, the installation of five new curing booths, and the relocation of small shops from the VAB and from the Hypergol maintenance facility.

A second project at KSC, estimated to cost $1,740,000, is for the rehabiliation and modification of facilities for payload ground support operations. These are required to meet safety standards and codes for the Delta spin test facility and explosive safe area 60, which are essential spacecraft servicing facilities. Modifications are also required to provide payload-to-user data cabling in the Operations and Checkout building, to provide cabling connecting the communication centers on KSC and the Cape Canaveral Air Force Station, and to modify the operations checkout building to provide a dedicated area for astronaut preflight physiological testing.

The largest Shuttle facility requirement is the modification of manufacturing and final assembly facilities for external tanks at Michoud in the amount of $17,845,000. This project continues work funded in fiscal year 1982 and prior years to provide the capability for the fabrication, assemly, testing, and checkout, and application of thermal protection systems [TPS] for the external tanks. Current evaluations based on TPS application experience to date have revealed the need for two additional TPS spray cells for the LO_2

tanks and the intertanks to achieve necessary increases in production rates.

The addition of a new 75-ton bridge crane in the vertical assembly building is also necessary to support future external tanks production schedules and eliminate a single point of failure in the manufacturing flow. The main manufacturing plant will be modified to provide a 45-foot clear aisle the full length of the building to alleviate material and component crossflow, backflow congestion, and aisle blockage which now prevent orderly and efficient manufacturing processes. In addition, the crane system in the liquid hydrogen tank welding area requires upgrading to support increased production rates. External tank TPS closeout operations are conducted in the final horizontal assembly positions as a last step in the manufacturing process. External flight hardware is attached to the external tanks in these locations and stringent control of temperature, humidity, and cleanliness level is required during TPS closeout operations to preclude debonding of the insulation. These modifications are required to provide the necessary controlled environment.

Moving to aeronautics and space technology projects, to enhance the utilization of our unique NASA aeronautical facilities, a total of $24,615,000 is requested for aeronautics and space technology facility projects. One of our most critical requirements is the need for a consolidated data analysis facility at the Dryden flight research facility which is estimated to cost about $4.5 million. The facility is required to house new computers and ancillary equipment and to consolidate the data automation activities at Dryden in an adequate facility. The existing computer equipment is not of sufficient capacity to provide the quality and quantity of flight test data reduction and analysis required to support current and future research and test needs at Dryden. These computers are being replaced in 1983 and 1984. Data analysis operations are currently dispersed in several locations with inadequate security, fire protection, and space requirements.

The largest aeronautics facility project is a proposed $9 million modification of the transonic dynamics tunnel [TDT] at Langley. The TDT is used by both Government and industry for research testing to verify flutter and other aerodynamic characteristics of high speed aircraft designs. The TDT's special features include continuous transonic, variable-density flow, a large 16- by 16-foot test section, and the flexibility to use either dense Freon-12 gas or air as the test medium. The heavy demand for these capabilities is evidenced by a current backlog of work that is in excess of 2 years. The major deficiency is an inadequate capability for scaling the ratio of aircraft mass to airstream density. The proposed modifications will permit increasing the test medium density by 50 percent, thereby greatly increasing the tunnel's capability for accurately scaled testing of heavy models. The major cost elements are the upgrading of the 20,000-horsepower drive system by 50 percent, providing additional cooling to accommodate the increased tunnel drive power, and modifying power and control systems.

A second wind tunnel project at Langley is the modifications to the 4- by 7-meter low speed tunnel, estimated to cost $7,200,000. A 2-year backlog of test requirements for this tunnel also exists de-

spite a two-shift operation since the tunnel was placed in operation in 1970. These modifications are required to improve the tunnel flow quality and increase productivity. Approximately 20 percent of the tunnel occupancy time is now required for test article installation and calibration. The modifications will include doubling the size of the model preparations area and building new model support carts to ease model preparation and checkout; developing a rotor test area for helicopter models; enlarging the control room, and improving the tunnel circuit flow. These modifications are expected to increase useful test time approximately 17 percent.

One other major aeronautical test facility project is the modification of the 450-pound-per-square-inch air system at the Lewis Research Center, estimated to cost $2,920,000. This air system provides compressed air to the majority of propulsion test facilities at Lewis. The present compressor is over 30 years old, subject to major breakdowns, and must be replaced to provide necessary reliability and continued operations. The old machine will be retained as a backup unit.

The rocket engine test facility, also at Lewis, currently provides for sea level testing only of low-thrust chemical rocket engines. Modification of the facility to provide altitude testing that will simulate the space environment is required. The estimated cost is $995,000. The modifications will provide an altitude exhaust system, including the addition of a test engine capsule, diffuser, spray cooler, ejector, and supporting control system.

One other major project that I would like to address briefly is a $2,150,000 rehabilitation project at the Wallops Flight Center. This is required for resurfacing portions of the airfield runways and taxiways, repairing cracked slabs and surface spalls, and general rehabilitation of the 26-year-old airfield pavement surfaces. Repairs and resurfacing are needed now to preclude aircraft damages due to engine injestion of pavement debris, prevent further pavement degradation, and reduce airfield maintenance and repair costs. Keeping the Wallops airfield in a serviceable condition is essential for current and future aeronautical research activities.

Completing this fiscal year 1983 COF budget request is $39 million for repair, rehabilitation and modifications, and minor construction, and $8.25 million for facility planning and design. Repair of facilities, not in excess of $500,000 per project, totals $15 million. The repair program is designed to provide a means of restoring our facilities to their originally intended and designed capability. The work is of such magnitude and nature that it cannot be accomplished by routine day-to-day maintenance and repair activities. These projects were distilled from over $25 million of priority items. Twenty million dollars is requested for rehabilitation and modifications projects under $500,000 per project. The purpose of this program is to protect, preserve, and enhance the capabilities of facilities so that they can accomplish the intended mission in a more efficient, safe, and economical manner. These projects are the highest priority items selected from total requests exceeding $33 million. The third element of the minor program is the minor construction projects not in excess of $250,000 each. These projects total $4 million and consist of new construction and additions to improve the usefulness of NASA's physical plant in response to

changes in utilization and adaptations required by changes in technology or mission needs.

Finally, we are requesting $8.25 million to conduct the necessary advanced planning and design. Typical of the activities financed by this element of the budget request are preliminary engineering reports, cost estimating, scheduling, final design, site investigations, engineering studies, and installation master planning. These are extensions and continuations of prior years' efforts required to provide the sound planning, design, and estimating that are essential to providing facilities at the least cost and within the time needed.

In summary, this $100 million budget request for NASA facilities work in fiscal year 1983 is a very lean program which addresses our most urgent facility requirements for carrying out the principal research, development, and testing activities and provides for the most essential repair and rehabilitation needs. We sincerely appreciate your support of our facility programs in the past and request your favorable consideration of the fiscal year 1983 COF budget request.

Mr. FLIPPO. We have a vote on the floor. I suppose we are now down to the second bell. I want to give the gentleman from California an opportunity to raise any questions that he might have with the general before we go to vote.

Mr. GOLDWATER. We do not have time to catch that vote. I have one question.

You mentioned the Ames wind tunnel. What is the status of that?

General MCGARVEY. It is overall approximately 90 percent complete at this stage. It will be completed in the midsummer of this year and become operational in the late calendar year.

Mr. GOLDWATER. Is that on target?

General MCGARVEY. It is about 6 months behind our initial schedule that was projected 5 years ago when we put the first element of the funding in the program. We are within the $85 million, and we expect to complete it within the $85 million.

Mr. GOLDWATER. That is the only question I have.

Mr. FLIPPO. Thank you.

General, I would like to ask in regard to Wallops Island. How long are airfield operations scheduled at Wallops Island; that is, specific operations which require an airfield as a component of the R. & D. work? Are any other NASA or Air Force fields able to accommodate those?

General MCGARVEY. Yes, sir, it is projected to continue in support of those aeronautical research activities for the foreseeable future. As you may know, Langley Research Center is the heavy user of the airfield at Wallops for general aviation spin testing, for antiskid, and for braking testing and development. We have had a program in the past for the terminal configured vehicle, for which the majority of the funding was eliminated in the fiscal year 1983 budget request; but there are plans underway to try to continue that activity out of the research and technology base.

We foresee a continuing requirement to utilize the Wallops airfield. There are no other airfields that are similarily instrumented. These are highly instrumented runways in support of that kind of research activity. Conceivably, you could move the work to Dryden,

but the additional cost of flying back and forth from the Langley area and the additional instrumentation cost certainly would not make it cost effective to do that.

Mr. FLIPPO. General, we have a series of questions, in particular with regard to the external tank operations, which we would like to submit to you for responses in writing for the record at a future time.

General MCGARVEY. We will be happy to do so.

[The prepared statement, plus answer to questions asked of General McGarvey follow:]

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
March 4, 1982

STATEMENT

OF

BILLIE J. McGARVEY
DIRECTOR OF FACILITIES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS, AND
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

Messrs. Chairmen and Members of the Subcommittees:

I appreciate this opportunity to appear before you today to present the NASA FY 1983 Construction of Facilities Budget request. Our budget request totals $100 million as compared to $104.8 million requested in FY 1982 and $98.7 million that is now available for FY 1982. Although the program is not large, it is an extremely essential program that provides the contractual services for necessary repairs, rehabilitation and modification of existing facilities, construction of new facilities, acquisition of related facility equipment and the planning and design of facility projects which support the research, development, and testing activities of the Agency.

The present NASA physical plant represents capital investments of over $7 billion and a replacement value of more than $20 billion. This physical plant is comprised of unique aerospace research, development, test and operational facilities and equipment. Our FY 1983 CoF Budget request has been structured to meet our continuing objective of preserving and enhancing the capabilities and usefulness of this physical plant. The proposed program is a lean but balanced response to requirements which exceed the funding limitations dictated by today's economic environment. The request is a program made up of only our highest priority needs. In highlighting the salient features of the budget request, I will briefly discuss several of the large, discrete projects and then summarize the minor program and planning and design activities.

Prior to addressing the details of the current request, I would like to update you on the status of some selected projects that have been high interest items in earlier budgets. The two Large Aeronautical Facility projects

costing $85 million each are now nearing completion of construction. The National Transonic Facility (NTF) at the Langley Research Center is approximately 95 percent complete and should be completed in July 1982. Upon completion of construction, the checkout and activation activities will begin, leading to full operations by the end of this calendar year. Likewise, the Modifications of the 40x80-Foot Subsonic Wind Tunnel at the Ames Research Center are proceeding satisfactorily. The overall construction is approximately 90 percent complete with the repowering of the 40x80-foot tunnel circuit 95 percent complete, and the new 80x120-foot test leg addition 80 percent complete at this stage. Construction should be completed in mid-1982 and the facility should become operational in late 1982. Both of these projects have been significant challenges in terms of technical design requirements and construction management, and barring any unforeseen major problems, we anticipate that future updates to you on these facilities will be in terms of research being accomplished and the results achieved.

A second item of continuing interest pertains to the Shuttle launch facilities at the Kennedy Space Center. The facilities supporting the first two launches have performed flawlessly and have suffered very little damage from the launches. We are particularly pleased that repair or renovation of launch facilities have not been pacing items affecting turnaround activities between Shuttle flights.

A final update item is the status of our energy conservation program. As you will recall, NASA established a goal of reducing the consumption of utilities energy by 50 percent by FY 1985 as compared to a FY 1973 baseline. This goal has provided the incentive for developing energy retrofit projects and improving facility operations. A 40 percent overall reduction that was reached last year was sustained in FY 1981 despite increased energy needed for Space Shuttle operations. Our current assessment is that we will probably achieve closer to a 45 percent reduction by FY 1985 than the 50 percent prediction. However, we are continuing to seek further reductions and improvements where feasible.

Space Transportation Systems

We are requesting $23,145,000 for Space Shuttle and Payload Facilities with the major projects located at the Kennedy Space Center (KSC) and the Michoud Assembly Facility (MAF). The Modifications of Solid Rocket Booster (SRB) Refurbishment and Subassembly Facilities at KSC, estimated to cost $1,700,000, are required to support the flight rates projected for FY 1984 and subsequent years. Experience with the first two Shuttle flights and related SRB studies have shown that additional capabilities for refurbishing and assembling forward and aft skirts, frustrums, and nose cones are required to support future flight rates. The principal thrust of this project is the

relocation of forward assembly buildup areas within the low bay of the Vehicle Assembly Building (VAB), the installation of five new curing booths, and the relocation of small shops from the VAB and from the Hypergol Maintenance Facility.

A second project at KSC, estimated to cost $1,740,000, is for the Rehabilitation and Modification of Facilities for Payload Ground Support Operations. These are required to meet safety standards and codes for the Delta Spin Test Facility (DSTF) and Explosive Safe Area-60 (ESA-60) which are essential spacecraft servicing facilities. Modifications are also required to provide payload-to-user data cabling in the Operations and Checkout (O&C) Building, provide cabling connecting the communication centers on KSC and Cape Canaveral Air Force Station (CCAFS), and to modify the O&C Building to provide a dedicated area for astronaut preflight physiological testing. The O&C modifications include the installation of a vestibular acceleration sled to record astronaut physiological data before and after flight.

The largest Shuttle facility requirement is the Modification of Manufacturing and Final Assembly Facilities for External Tanks (ET) at the Michoud Assembly Facility (MAF) in the amount of $17,845,000. This project continues work funded in FY 1982 and prior years, to provide the capability for the fabrication, assembly, testing and checkout, and application of thermal protection systems (TPS) for External Tanks. Current evaluations based on TPS application experience to date have revealed the need for two additional TPS spray cells for LO_2 tanks and intertanks to achieve necessary increases in production rates. The addition of a new 75-ton bridge crane in the Vertical Assembly Building is also necessary to support future ET production schedules and eliminate a single point of failure in the manufacturing flow. The Main Manufacturing Plant will be modified to provide a 45-foot clear aisle the full length of the building to alleviate material and component crossflow, backflow congestion, and aisle blockage which now prevent orderly and efficient manufacturing flows. In addition, the crane system in the LH_2 tank welding area requires upgrading to support increased production rates. ET TPS closeout operations are conducted in the final horizontal assembly positions as a last step in the manufacturing process. External flight hardware is attached to the ET in these assembly locations and stringent control of temperature, humidity and cleanliness level is required during TPS closeout to preclude debonding of the insulation. These modifications are required to provide the necessary controlled environment.

Aeronautics and Space Technology

To enhance the utilization of our unique NASA aeronautical facilities, a total of $24,615,000 is

requested for Aeronautics and Space Technology facility projects. One of our most critical requirements is the need for a consolidated Data Analysis Facility at the Dryden Flight Research Facility (DFRF) estimated to cost $4.5 million. The facility is required to house new computers and ancillary equipment and consolidate the data automation activities at Dryden in an adequate facility. The existing computer equipment is not of sufficient capacity to provide the quality and quantity of flight test data reduction and analysis required to support current and future research and test needs at DFRF. These computers are being replaced in FY 1983 and FY 1984. Data analysis operations are currently dispersed in several locations with inadequate security, fire protection, and space requirements.

The largest Aeronautics facility project is a proposed $9,000,000 Modification of the Transonic Dynamics Tunnel (TDT) at the Langley Research Center. The TDT is used by both government and industry for research testing to verify flutter and other aerodynamics characteristics of high speed aircraft designs. The TDT's special features include continuous transonic, variable-density flow; a large 16-foot by 16-foot test section; and the flexibility to use either dense Freon-12 gas or air as the test medium. The heavy demand for these capabilities is evidenced by a current backlog of work in excess of 2 years. The major deficiency of the TDT is an inadequate capability for scaling the ratio of aircraft mass to air stream density. The proposed modifications will permit increasing the test medium density by 50 percent, thereby, greatly increasing the tunnel's capability for accurate scaled testing of heavy models. The major cost elements are the upgrading of the 20,000 horsepower drive system by 50 percent, providing additional cooling to accommodate the increased tunnel drive power, and modifying power and control systems.

A second wind tunnel project at Langley is the Modifications to the 4x7-Meter Low Speed Tunnel (LST) estimated to cost $7,200,000. A two-year backlog of test requirements for this tunnel also exists despite a two-shift operation since the LST was placed in operation in 1970. These modifications are required to improve the tunnel flow quality and increase productivity. Approximately 20 percent of the tunnel occupancy time is now required for test article installation and calibration. The modifications will include doubling the size of the model preparations area and building new model support carts to ease model preparation and checkout; developing a rotor test area for helicopter models; enlarging the control room, and improving the tunnel circuit flow. These modifications are expected to increase useful test time approximately 17 percent.

Another major Aeronautical test facility project is the Modification of the 450 Pound Per Square Inch (PSI) Air System at the Lewis Research Center estimated to cost

$2,920,000. The 450 PSI Air System provides compressed air to the majority of propulsion test facilities at Lewis. The present compressor is over 30 years old, subject to major breakdowns, and must be replaced to provide necessary reliability and continued operations. The old machine will be retained as a backup unit.

The Rocket Engine Test Facility (RETF) at Lewis currently provides for sea-level testing only of low thrust chemical rocket engines. Modification of the facility to provide altitude testing that will simulate the space environment is required. The estimated cost is $995,000. The modifications will provide an altitude exhaust system to permit high altitude simulation. The required work includes the addition of a test engine capsule, diffuser, spray cooler, ejector, and supporting control system.

Other Major Projects

A $2,150,000 Rehabilitation project at the Wallops Flight Center (WFC) is required for resurfacing portions of the airfield runways and taxiways, repairing cracked slabs and surface spalls, and general rehabilitation of the 26-year old airfield pavement surfaces. Repairs and resurfacing are needed now to preclude aircraft damages due to engine injestion of pavement debris, prevent further pavement degradation, and reduce airfield maintenance and repair costs. Keeping the Wallops airfield in a serviceable condition is essential for current and future aeronautical research activities.

Minor Facility Projects

Completing this FY 1983 CoF Budget request is $39 million for Repair, Rehabilitation and Modifications, and Minor Construction, and $8.25 million for Facility Planning and Design.

Repair of Facilities, not in excess of $500,000 per project, totals $15 million. The Repair Program is designed to provide a means of restoring our facilities to their originally intended and designed capability. The work is of such magnitude and nature that it cannot be accomplished by routine day-to-day maintenance and repair activities. These projects were distilled from over $25 million of priority items.

$20 million is requested for Rehabilitation and Modification Projects under $500,000 per project. The purpose of this program is to protect, preserve and enhance the capabilities of facilities so that they can accomplish the intended mission in a more efficient, safe, and economical manner. These projects are the highest priority items selected from total requests exceeding $33 million.

The third element of the Minor Program are the Minor Construction Projects not in excess of $250,000 each. These

projects total $4 million and consist of new construction and additions to improve the usefulness of NASA's physical plant in response to changes in utilization and adaptations required by changes in technology or mission needs.

Finally, we are requesting $8.25 million to conduct the necessary advanced planning and design. Typical of the activities financed by this element of the budget request are preliminary engineering reports, cost estimating, scheduling, final design, site investigations, engineering studies, and installation master planning. These are extensions and continuations of prior years efforts required to provide the sound planning, design, and estimating that are essential to providing facilities at the least cost and within the time needed.

Summary

In summary, this $100 million budget request for NASA facilities work in FY 1983 is a very lean program, which addresses our most urgent facility requirements for carrying out the principal research, development, and testing activities and provides for the most essential repair and rehabilitation needs. We sincerely appreciate your support of our facility programs in the past and request your favorable consideration of the FY 1983 CoF budget.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY CHAIRMAN FLIPPO DURING THE JOINT HEARINGS BEFORE THE SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS AND THE SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS ON MARCH 4, 1982, TO GENERAL MCGARVEY

QUESTION 1:

Given the TPS spray cells K & L, what future cells remain to be constructed and what will be the annual ET production rate with all cells in operation?

ANSWER 1:

With the completion of cells K & L requested in our FY 1983 budget, no additional cells are needed to achieve the current planned production rate of 24 tanks per year in 1987. This will support the planned flight rate of 24 per year in 1988. We estimate that with all cells in operation a production rate in excess of the 24 tanks per year (approximately 28) would be possible.

QUESTION 2:

What engineering studies exist to support the work flow in the finishing cells area? What is the probability that the work flow and tasks presently assigned to the cells will have to be changed at a later date to accommodate the higher ET production rates?

ANSWER 2:

There are three separate and independent studies in addition to the in-house studies done by MSFC. The three studies were done under contracts with:

(1) A. T. Kearney, Inc.
(2) Sverdrup & Parcel Associates, Inc.
(3) Ingersoll Engineers

We believe that there is a low probability that the work flow and tasks presently assigned to the cells will have to be changed to accommodate higher ET production rates above 24 per year. The potential for production rates above 24 per year was considered when the work flows and work assignments were made to assist in minimizing future changes.

QUESTION 3:

Is the proposed east/west production flow aisle optimum? Will it extend the full distance from one end of the plant operations to the other? If not, what are the limitations and how will they impact tank production?

ANSWER 3:

The three consultants cited in answer 2 above recommended the east/west production flow aisle. MSFC and the Martin Co. have also

thoroughly assessed this layout. Therefore, we are reasonably confident that the east/west layout is an optimum approach.

The aisle is a 45-foot wide, floor to ceiling space through the entire building (103).

QUESTION 4:

Why wasn't the primary power distribution system at Pad B included in the FY 1980 (or earlier) Pad B modification work:

ANSWER 4:

When the FY 1980 LC-39 project for Pad B was formulated in CY 1978, it was envisioned that the 60 hertz system would not require major refurbishment. However, during the activation of Pad A after construction completion in CY 1979 it was found that many electrical components of the distribution system need replacement. This prompted a survey of Pad B during which similar deficiencies were also discovered. Since it was too late to include the work in the FY 1980 project, it was determined that a FY 1983 CoF project could be completed in time to meet the operational readiness date for Pad B.

QUESTION 5:

How long are airfield operations scheduled for at Wallops Island? (That is, specific operations which require an airfield as a component of the R&D work). Are any other NASA or USAF fields able to accommodate these activities?

ANSWER 5:

We plan to continue R&D test operations out of Wallops Flight Center (WFC) for the foreseeable future. Although the Terminal Configured Vehicle (TCV) aircraft program, a prime user of the Wallops Flight Center landing systems, is not being funded as a R&D budget line item in the FY 1983 aeronautics budget, the type of work to be carried out with the aircraft will continue. At the present time there are no other facilities close to Langley which have microwave landing equipment and unique runway landing aids which permit terminal area operations without the safety hazards associated with mixing this aircraft in normal heavy traffic flows. There are no other airports or facilities at NASA or USAF which have the high speed turnoff aids and/or instrumented facilities for test of tire hydroplaning, engine ingestion of water spray, and anti-skid braking tests. Terminal area operations with advanced guidance and control systems is an expanding area of NASA aeronautical research. The research on general aviation aircraft spin testing also requires the use of the unique Wallops capabilities, however, because of policy decisions this research will be reduced from that in recent years.

QUESTION 6:

Can all or part of the rotor development work to be accomplished in the 4X7-Meter Low Speed Tunnel be accomplished at Ames? If so, what percentage?

ANSWER 6:

No. The Langley Research Center 4X7-Meter Low Speed Tunnel (LST) is the only medium-sized facility in which models of sufficient scale can be tested to establish their acoustic signatures and characteristics. The larger tunnels at Ames Research Center require much larger (and much more expensive) models or full scale aircraft, which is not a cost effective way to conduct this type of research, where parametric evaluations of the aerodynamic and acoustic characteristics of rotor models is required.

The 4X7-Meter LST is used extensively in joint Army/NASA programs to develop advanced rotorcraft technology. It is unique in that it can be operated as a closed or open throat tunnel. This capability plus its moving belt floor permit realistic acoustic and ground effects studies. The rotorcraft industry considers the 4X7-Meter Tunnel the premier acoustic wind tunnel for scale model testing.

QUESTION 7:

What other facilities exist in either NASA or USAF that can be used to accomplish the research proposed for the Transonic Dynamics Tunnel?

ANSWER 7:

Every military aircraft configuration and many of the commercial transport aircraft such as the Boeing 767 are tested in the Transonic Dynamics Tunnel (TDT) to establish flutter boundaries. Its unique capability stems from the high density test medium which permits properly scaled testing for the highly instrumented models with adjustable control surfaces which are used for flutter research. No other facility exists anywhere in NASA, the military, or U.S. industry, where such testing can be performed.

QUESTION 8:

Given the current budget climate and the degree of completion on Space Shuttle Facilities, what is the reason for budgeting $1,300,000 for continuing planning and design?

ANSWER 8:

The $1,300,000 is required for long-lead planning and design needs in the FY 1984 and 1985 time frame to support the operational phase of the Space Transportation System.

The requested amount is essential to the development of reliable cost estimates, optimum designs, and construction bid packages.

QUESTION 9:

What energy conservation projects were eliminated, if any, from NASA's budget that would have had reasonable short-term payback? If any, were they eliminated for budgetary purposes?

ANSWER 9:

The following energy conservation projects could not be accommodated within the very constrained Fiscal Year 1983 Construction of Facilities Budget.

A. Modifications to Various Buildings for Energy Conservation

This $2,700,000 project at Langley Research Center would save approximately $640,000 per year (7,000,000 KWH/year) in utility costs and pay for itself in 4 years.

B. Modifications Site Heating, Ventilation, and Air Conditioning System for Energy Conservation

This $3,000,000 project at National Space Technology Laboratories has an estimated simple payback of less than 4 years. It would save approximately 13 % (199 x 10^9 BTU/year) of the National Space Technology Laboratories base year energy use.

Mr. FLIPPO. Thank you very much for being with us.

General MCGARVEY. Thank you, sir.

Mr. FLIPPO. I believe this concludes this series of hearings. The committee stands adjourned.

[Whereupon, at 11:13 a.m., the committee recessed, to reconvene at the call of the Chair.]

APPENDIX

Additional Questions and Answers for the Record

QUESTION 1:

Please provide historical trend data (FY 1979 through FY 1983) showing the number of trips taken and planned in the three travel categories. Data should be normalized to end-of-year FY 1982 personnel ceilings.

ANSWER:

The historical trend normalized to end-of-year FY 1982 personnel ceiling is provided below:

	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983
Normalized Trips:					
Program Travel	34,964	33,670	30,062	35,221	33,785
Management and Operations Travel	5,847	5,474	5,664	6,238	5,955
Scientific and Technical Development Travel	3,621	3,083	2,660	2,988	2,880
Normalized Total	44,433	42,227	38,386	44,447	42,620
Total Actual Trips:	46,447	44,101	38,778	44,447	41,768

QUESTION 2:

What is the amount, by agency, expected in FY 1982 and FY 1983 from other agencies and commercial customers to reimburse NASA for the salaries and benefits of civil service employees?

ANSWER:

Listed below are the dollars expected in FY 1982 and FY 1983 from other agencies and commercial customers to reimburse NASA for the salaries and benefits of civil service employees, and the number of workyears covered.

Agency	FY 1982		FY 1983	
	Amount ($ in Thousands)	Workyears	Amount ($ in Thousands)	Workyears
Department of Energy	$8,656	207	$5,622	101
Department of Commerce (NOAA)	2,881	64	3,937	77
Department of Defense (Air Force)	1,342	32	1,538	31
Other Government Agencies	765	16	748	16
Non-Federal Sources	6,681	184	6,500	172
Total	20,325	503	18,345	397

QUESTION 3:

Please provide trend data (FY 1979 through FY 1983) showing utility usage (BTU's) and total costs.

ANSWER:

The R&PM utility energy usage (Source BTU's) and the R&PM total utility costs are as follows:

	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983
BTU's (10^{12}) (Source)	15.7	15.5	14.5	14.72	14.67
Costs in Thousands	$46,724	55,434	63,398	76,802	89,505

Usage is projected to decrease by 47 billion BTU's from FY 1982 to FY 1983 even though there are substantial usage increases projected at Ames Research Center due to the 80' x 120' wind tunnel becoming fully operational and to an increased level of high speed wind tunnel tests.

QUESTION 4:

What is the number and cost, by center, of reimbursable detailees and R&D funded post-graduate fellows for FY 1982 and FY 1983?

ANSWER:

	FY 1982				FY 1983			
	Reimbursable Detailees		Post-Graduate Fellows		Reimbursable Detailees		Post-Graduate Fellows	
	Wkys	$K	#	$K	Wkys	$K	#	$K
ARC	5	186	58	1,914	7	272	58	2,030
GSFC	–	–	52	1,716	–	–	52	1,820
HQ	12	532	–	–	13	585	–	–
JSC	73	3,141	10	330	77	3,386	10	350
KSC	1	37	–	–	–	–	–	–
LaRC	–	–	21	692	–	–	21	735
LeRC	–	–	23	759	–	–	23	805
MSFC	–	–	14	462	–	–	14	490
NSTL	–	–	–	–	–	–	–	–
NASA	91	3,896	178	5,874	97	4,243	178	6,230
JPL			23	759			23	805
Total			201	6,633			201	7035

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QUESTION 5:

What is the baseline number, by center, of R&PM support contractors in FY 1982 and FY 1983? What are the costs associated with the total number of support service contractors in FY 1982 and FY 1983?

ANSWER:

The baseline values for R&PM support contractors for FY 1982 and FY 1983 are shown by center in the table below:

	FY 1982	FY 1983
ARC	263	263
GSFC	405	405
HQ	380	354
JSC	770	770
KSC	1,529	1,529
LaRC	279	279
LeRC	208	207
MSFC	532	532
NSTL	12	12
TOTAL NASA	4,378	4,351

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The costs associated with these support service contractors are $127,771,000 for FY 1982 and $139,625,000 for FY 1983.

QUESTION 6:

How much is included in FY 1982 and FY 1983 for lease, purchase, and maintenance and operations of ADP equipment?

ANSWER:

The FY 1983 R&PM budget estimate provides for the following:

	FY 1982	FY 1983
	(Dollars in Millions)	
ADP Equipment	5,310	6,733
ADP Operations	23,180	24,585
TOTAL	28,490	31,318

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QUESTION 7:

For FY 1982 and FY 1983, what is the cost of rental of land and property? How much space is leased?

ANSWER:

The R&PM FY 1983 budget estimate provides for the following:

	FY 1982	FY 1983
Total Costs ($ in thousands)	5,658	8,061
(Rental from GSA)*	(5,456)	(7,838)
Total Space Leased (sq. ft.)	612,195	587,780
(Rental from GSA)*	(599,695)	(575,280)

*Includes Standard Level User Charges (SLUC) paid to GSA mainly for NASA Headquarters use of Federal office buildings in the District of Columbia

QUESTION 8:

How much is included in FY 1982 and FY 1983 for rental of passenger vehicles (except GSA), GSA passenger vehicles, movement of goods and administrative aircraft operations? How many vehicles are covered by these funds? Also show dollar amounts for the number of vehicles provided to contractors.

ANSWER:

The following data is included in the R&PM FY 1983 budget estimate:

	FY 1982 ($ in thousands)	FY 1983 ($ in thousands)
Rental of Passenger Vehicles (except GSA)	49	90
Rental of GSA Passenger Vehicles (includes vehicles provided to NASA contractors when proven more economical and advantageous to the Government)	1178	1364
	(147)	(164)
Movement of Goods	4094	4063
Administrative Aircraft Operations	4986	5792
Number of Vehicles Covered (includes vehicles provided to NASA contractors)	274	283
	(30)	(30)

QUESTION 9:

Summarize the results of the NASA EEO recruitment program over the past year.

ANSWER:

The information requested is as follows:

Overall: During FY 1981, the further reduction in the NASA work force resulted in fewer hiring opportunities. Minorities in non-professional positions decreased in number but increased in percent. Minorities and women in professional positions increased in both numbers and percent.

	1980	Δ	1981
Total population	22,613	-769	21,844
(%)		(-3.4%)	
Minorities	2,494	-22	2,472
(%)	(11.0%)	(-.9%)	(11.3%)
Women	4,812	-101	4,711
(%)	(21.3%)	(-2.1%)	(21.6%)

Professionals: 12.5% of professional hires were minorities. 16.8% of professional hires were non-minority women.

Over the last year, the percentage of minority professionals in the work force increased from 8.1 percent to 8.4 percent. The percentage of non-minority women increased from 9.0 percent to 9.6 percent.

Non-Professionals: 22.7% of non-professional hires were minorities.

Over the last year, the percentage of minority non-professionals rose from 16.6 percent to 16.9 percent although they decreased in number from 1304 to 1254.

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QUESTION 10:

What are the costs, by center, of both DTMS and DMS for FY 1982 and FY 1983?

ANSWER:

R&D PROGRAM SUPPORT ESTIMATED FUNDING REQUIREMENTS
BY INSTALLATION
(Millions of Dollars)

	FY 1982		FY 1983	
	DTMS	DMS	DTMS	DMS
Ames Research Center	--	7.3	--	9.0
Goddard Space Flight Center	--	25.3	--	30.0
Johnson Space Center	94.2	10.0	58.5	10.0
Kennedy Space Center	65.1	1.9	2.8	2.0
Langley Research Center		19.5	--	21.4
Lewis Research Center		9.8	--	10.8
Marshall Space Flight Center	18.0	9.1	15.7	9.8
National Space Technology Laboratories	5.2	--	4.7	--
Headquarters	1.5	--	.7	--
TOTALS	184.0	82.9	82.4	93.0

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QUESTION 11:

Please provide a by-Center report of progress against the 50% utility usage savings goal. Also describe further actions to be taken and expected savings.

ANSWER:

The progress of each NASA field installation against the 50 percent utility savings goal is as follows:

Field Installation	% Reduction From FY 1973 Actuals Through FY 1981
Ames Research Center	44
Downey Industrial Plant	17
ARC/Dryden Flight Research Facility	+4
Goddard Space Flight Center	33
Jet Propulsion Laboratory	39
Johnson Space Center	45
Kennedy Space Center	43
Langley Research Center	41
Lewis Research Center	35
Marshall Space Flight Center	48
Michoud Assembly Facility	30
National Space Technology Laboratories	42
GSFC/Wallops Flight Center	34
Others	58
NASA TOTAL	40

The following are some of the significant actions that should further contribute towards achieving the 50 percent utilities reduction goal:

Goddard Space Flight Center: Continued conversion of air conditioning systems to the more efficient, variable air volume operation.

Kennedy Space Center: Down-sizing of chillers and continued building energy retrofits.

Langley Research Center: Continued operation of the Refuse-Fired Steam Generator Plant.

Marshall Space Flight Center: Further modifications to chillers and lighting systems to reduce energy.

Various Locations: A major effort is being planned that will attempt to further improve operations of facilities and equipment to reduce the energy needed to accomplish our day-to-day missions.

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QUESTION 12:

Please provide data showing escalation rates for support contractor services.

ANSWER:

The escalation rates projected for support contractor services are shown in the table below:

	FY 1981 to FY 1982 % Change	FY 1982 to FY 1983 % Change
ARC	9.5	10.5
GSFC	6.8	8.3
HQ	7.8	8.9
JSC	15.5	9.0
KSC	8.1	9.9
LaRC	11.6	11.0
LeRC	11.0	13.9
MSFC	8.6	10.5
TOTAL NASA	9.5	9.9

QUESTION 13:

Summarize the results of the second round of SES bonuses.

ANSWER:

In 1981, NASA followed the Office of Personnel Management's guidance and awarded bonuses to 19.9 percent of our SES career employees. This percentage equated to 94 of our 472 eligibles receiving bonuses. A breakdown of the 94 bonuses follows:

Number of Bonuses	Amount of Bonus
5	$10,000
5	9,000
14	7,000
70	5,000

While NASA strictly adhered to OPM guidance regarding bonuses in 1981, we still believe that these restrictions are most unfortunate. The majority of our SES personnel continue to be employees who were converted in 1979 with the understanding that 50 percent of their number would be eligible each year for a bonus. Employee confidence in the SES is still being eroded by the failure of their Government to live up to this commitment.

This severe limitation results in NASA having many deserving candidates for bonuses that simply cannot realistically expect to receive one. The further reduction in the number of bonuses for FY 1982 serves to worsen the situation. The original purpose of bonuses was to encourage excellence in performance by career SES members. We do not believe that the bonus system achieves that goal under these conditions.

Perhaps, if the money for bonuses were controlled rather than the number of bonuses paid, a more meaningful distribution of such recognition could be achieved by the individual agencies administrators.

QUESTION 14:

Summarize the results of the first year under "Merit Pay".

ANSWER:

On October 4, 1981, 2,894 grade 13-15 managers and supervisors were converted to the Merit Pay system.

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The average Merit Pay increase during this first year of the program was $381 or approximately 0.9 percent of salary.

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Increases ranged from a low of zero for those less than successful to a high of $1,400 (about 3 percent) for those performing in an outstanding manner.

Last minute changes to program operation ordered by the Comptroller General and the Office of Personnel Management resulted in a reduction of the anticipated pay out by 50-60 percent. This has caused significant morale problems among the middle managers covered by Merit Pay because the amount many of them received was actually less than the amount received by their non-supervisory counterparts who happen to be performing at the same grade level.

While every effort was made within NASA to minimize the adverse consequences of this system, most of the key factors were beyond the Agency's control.

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QUESTION 15:

Please provide a current listing of re-hired annuitants.

ANSWER:

The following is a list of former NASA employees currently employed as re-employed annuitants (excludes experts and consultants):

Re-employed Annuitants as of 1/11/82

	Perm.	Temp.	Total
ARC	1	10	11
GSFC	--	--	--
HQ	4	2	6
JSC	5	1	6
KSC	--	--	--
LaRC	--	--	--
LeRC	--	--	--
MSFC	--	--	--
TOTAL	10	13	23

Recap

Perm	Temp
SES = 8	GS = 13
GS = 2	

Permanent

ARC — Giovannetti, Angelo - SES
Chief Engineer, Staff of the Director

HQ — Taylor, Charles A. - SES
Action in Process to Move

Dunlap, Frederick L. - SES
Director, Budget Operations Division

Williams, Walter C. - SES
Chief Engineer, NASA

Wilson, Glen P.
Special Assistant for Student Activities

JSC — Kraft, Christopher - SES
Center Director

Bond, Aleck C. - SES
Special Assistant to Director, Engineering and Development

Huss, Carl R. - SES
Assistant to the Director for Future Programs

Slayton, Donald K. - SES
Manager for Orbital Flight Test

JSC (con't) Chaney, Bailey - GS-15
Labor Relations Officer

Temporary

ARC Dusterberry, John C. - GS-15
AST, Technical Mgt., Wind Tunnel Project

Sadoff, Melvin - GS-15
Asst. Chief, Biomedical Research Division

Briggs, Lester - GS-14
Deputy Chief, Personnel Division

Tunnell, Phillips J. - GS-14
Technical Asst. to Director, Research Support

Barrie, Jack P. - GS-13
Chief, Facilities Services Branch

Monfort, James C. - GS-13
Senior Test Engineer, Unitary Wind Tunnel Facility

Barnett, Robert M. - GS-15
Manager, Simulator Development Project Office

McTique, John - GS-15
Chief, Flight Support Division

Saltzman, Edwin J. - GS-14
Aerospace Engineer, Part-time

Ruby-Malone, Ruth T. - GS-6
Personnel Clerk, Part-time

HQ Hammock, Barney C. - GS-15
Auditor

Jefferson, Dorothy - GS-12
Secretary/Steno

JSC Sjoberg, Sigurd A. - GS-15
Special Ass't to Director

1981 ACTIVITY REPORT
AEROSPACE SAFETY ADVISORY PANEL

I. Executive Summary

In 1981, the first two Shuttle flights were accomplished and the Aerospace Safety Advisory Panel (ASAP) logically concentrated on the process of preparation for flight and the gathering of information from these flights to confirm the concept and performance of the major elements of the Space Transportation System. In this year's activities it became obvious to the Panel that the safety of the Shuttle operation would be increasingly dependent on (1) the procedures for turnaround, (2) the ability to quickly assess system performance from flight experience, (3) the developing judgment concerning what needed to be rechecked for each operation, and (4) the astute creation of truly "operational" procedures which would be simple enough to realize cost saving and thorough enough to maintain safe and reliable operations. Following this line of reasoning, the ASAP has reviewed its membership, has revised it to amplify operational know-how, and has turned its attention to the operational plans that NASA is developing and the organization concepts that will be used in fulfilling those plans.

In the current budget environment, it is recognized that many of the significant system changes previously suggested by the ASAP and those recommended in this report will not be feasible for retrofit in the present Orbiter production series. As a direct result, a number of the present systems will require more

continuing special readiness attention than revised systems designed to be optimum for routine operation. Under these limiting circumstances the ASAP considers that the estimated 24 flights per year with 4 Orbiters will be very difficult to achieve. Having to use the hardware currently available should not prevent planning for an orderly R&D and certification program to create more nearly optimum operational systems. Such systems will then be available for incorporation in future Orbiters or for retrofit in the event that other factors, such as a demand for major performance improvements, dictate an extensive change program.

In reviewing the "incidents" which have occurred during STS-1 and STS-2 flights, it is apparent that the R&D nature of these first efforts, along with the reliance on complex paper systems for documenting the check and balance functions, have nearly obscured the necessity for personal, "on the floor," responsibility of supervision at all levels for safety and success. Many details of doubtful importance are raised to the highest management levels for decision by-passing the judgment of middle management and clouding the truly important issues that should be defined for major management decisions. The Safety Assessment Report, the Accepted Risk Summary, and the Critical Issues procedures as made available to the ASAP are examples of systems that should be reexamined for simplification and reorientation to identify the issues that truly need top

management attention. In this process simplified turnaround procedures should emerge, along with tighter discipline to assure properly scheduled events and avoid last minute improvizations which can introduce hidden hazards.

The concept of the transportation system itself, including the essential subsystems, should also be reviewed for operational simplicity along with the management and procedures. The ASAP has attempted to review the basic architecture of the essential subsystems and recognizes that, in a number of cases, the state-of-the-art in modern transports and military aircraft offers opportunities for improving the safety and reliability of Shuttle systems based on mature concepts that have been operationally proven. Specifically, the ASAP recommends a major audit of the concept of redundant systems as applied to the essential elements of the Shuttle. The Panel believes that a more consistent approach to redundancy throughout all systems will simplify the elements and reduce costs while enhancing safety. The Panel recognizes that changes of any kind must await schedule and budget "windows" but suggests that an orderly subsystem improvement program can reduce ultimate costs and improve turnaround time.

Previous advice to NASA on turnaround procedures implied changes in organizational functions within NASA. The ASAP has suggested that a purely operational organization should be created that would function like an airline or a military mission command as compared to an engineering and development organization. Such an operational entity would relieve the R&D organization of responsibilities it is ill-equipped to handle and would improve

the R&D function itself by stabilizing the performance requirements and by developing future customers to justify continuing development programs. The operational organization, it is suggested, should purchase services and hardware from the development part of NASA much as an airline purchases its transport aircraft, spares, technical support, and early training from the aircraft manufacturer.

II. STS-1 and STS-2 Turnaround Process and Base Operations

As could be expected, the turnaround of STS-1 and STS-2 had to be modified to accommodate the performance of major subsystems and the condition of these systems. As the Panel has reviewed these activities it is obvious that the preparation, and the basic design, produced a near miracle in functional success. The systems representing the most ambitious penetration of the state-of-the-art, the main engines and the thermal protection system, performed almost perfectly. Similarly, the control and attitude, primary instrumentation, and boost propulsion units all functioned as required. This remarkable performance must not be forgotten in reviewing potential improvements in the turnaround process -- it suggests that a number of present subsystems will readily demonstrate "operational status" and permits relaxation of "every flight" test and check requirements.

The Panel's annual report for 1980, in the section on NASA Review System, discussed the Panel's generally positive conclusions regarding the commitment of top management to achieve an acceptable level of risk prior to authorizing the first manned Orbital flight of the Space Shuttle. We can reaffirm these conclusions in the present annual report. Panel members participated in all major program and flight readiness reviews prior to STS-1 and STS-2. Concerns reported by the Panel to top management, such as Orbiter entry stability and control, Orbiter seat eject system, SRB overpressure, timely recovery of the crew after landing, STS-2 launch schedule, and flight control analysis of off-nominal conditions, were carefully examined and documented

reports were made to the Panel. The new NASA management team, from the Administrator on down, reaffirmed their predecessors' commitment to achieving an acceptable level of risk prior to the flight of STS-2.

Apparent in the preparation and turnaround was the predominant control of the process by the development practitioners of NASA and the understandable lack of patterns and experiments to reduce turnaround time and cost. Of particular concern to the ASAP was the apparent lack of "floor responsibility" at KSC. The Panel believes that the hypergolic propellant spill incidents demonstrate poor local supervision of specific procedures and a vague line of authority for essential tasks. Other evidence of poor discipline were instances of Shuttle damage by ground gear not clear of moving surfaces and ineffective access control of Shuttle areas not habitable due to the suspected presence of gases. The Panel recognizes the complexity of controlling a mix of personnel from other centers, many contractors, and base personnel, not to mention multiple advisors. The Panel also recognizes that written procedures by themselves can never substitute for capable "on the floor" supervision adhering to such procedures. Operations management must be in charge to make the total process successful. NASA organization responsibilities clear to the top need to be re-identified before simplification of the turnaround is achieved.

Of particular concern to the Panel from a design and system standpoint is the practice of major reprogramming between flights. For normal transport operations the essential content of the

airborne and ground support computer memories should remain untouched from flight to flight, limiting reprogramming to that necessitated by the particulr cargo being carried. Even this reprogramming should be approached on the basis that there will be common functions for all payloads that can be accommodated without mission to mission reprogramming except for constants or I-Loads.

A. Readiness Review Process

The ASAP believes that the readiness process needs to be reconstituted before it is effective for operations. To the Panel it appears that:

1. Reliability, safety, and quality organizations should be more clearly in the decision loops and the documentation process appears to be used more for post operation justification of actions than for deciding on readiness.
2. The documentation used for summarizing risk and evaluation of readiness as represented by the safety assessment report, the accepted risk summary, and the critical issues summary all appear to be dedicated to listing every possible concern so that retrospective examination will find no basis for criticizing thoroughness. These procedural activities did not appear to represent a management level by level evaluation of risks and a summary of judgmental total risk truly suitable for use by higher management.
3. The inherent assurance of having a separate operations team independently assess readiness,

as is the case with established transportation systems may not function adequately with NASA's present structure to assure an independent readiness opinion. Historically, management of the Space Transportation System has developed a pattern whereby Headquarters balances input from the "program," the centers, and the test community. Thus, no one organization within NASA has full responsibility for operations decisions. This must be modified before a routine and reliable operations function can achieve success.

B. Technical Audit Process

Among the many successes of STS-1 and STS-2 was a technical audit initiated at Houston to review and supplement the more routine sneak circuit analyses. This ad hoc function did not use "independent" evaluators or professional safety or quality assurance practitioners. It utilized the design team members who were responsible for major elements of the Shuttle systems and therefore had familiarity with the fundamentals of the systems and their limitations. They were also familiar with the test successes and failures and the interface functions among the elements.

The success of the ad hoc technical audit suggests that the process should be expanded in support of future Shuttle concept changes and improvement programs. It should also be considered by any new operations organization to assess routine processes and procedures and suggest new approaches which could save costs

without increasing hazards. The ASAP believes that the success of such ad hoc teams stems from the currency of their technical or operational experience, their total familiarity with the system and their lack of dedication to any routine reporting or documentation discipline.

C. Orbiter Performance and Control Margins

The R&D program of four flights may be adequate to assess the safe operation of the system, but routine efficient operations require knowledge of the boundaries of performance that may not be fully established within the planned R&D effort. A plan needs to be established for continued performance envelope expansion to improve operational utility. Examples of the limitations include, e.g. limits for re-entry control, launch tower clearance for broad weather variables, and a myriad of redline limits which must be cleared before launch.

The Panel is particularly concerned with the demonstrated ambivalence to "redline" limitations. Redline limits should be set, and presumably have been, by combining accumulated experience of both design and safety engineers. To override such judgment in the readiness and launch environment potentially introduces unevaluated risks. This should be avoided in any case and must be for any operational mode. The Panel conclusion from this experience is that "redlines" should be reassessed -- this may be a task for an ad hoc technical audit team. This could remove unjustified conservatism and could provide a rational basis for the rigid "redline" discipline which must be achieved.

III. New Function Emphasis for Transport Systems

The development of the Shuttle was a massive research and development task done by or under the direction of NASA's development-oriented centers. This was appropriate and successful. The task after the remaining development flights is to operate the present system in as economic and routine a manner as is possible. In addition, it is necessary to gain information that will create requirements for progressive improvements or needs that will become the basis for future new systems.

To achieve routine operation, the Panel believes that the Shuttle must be operated by a separate organization, with facilities dedicated to transportation services alone. Much like an airline or a military operational base, this organization should have no research and development charter nor capability but should be staffed by an experienced cadre of operational people. Although there are many capable "test" people in NASA the ultimate success of the transport system probably depends on NASA's ability to attract new people both in house and via contract. A clearly separate operations organization will be helpful in recruiting such talent.

Properly constituted and manned, such a transport organization would have the capability to:

- Assess hardware performance on the basis of operational reliability, reusability and low cost.
- Emphasize logistics planning, including spares.

- o Assess changes on a cost and reliability basis rather than on performance improvement alone and control these changes.
- o Base operations planning only on payload need thereby producing reliable schedules, and an operations budget plan that reflects cost savings due to learning.
- o Create requirements for future performance improvements based on "market" needs -- for NASA itself as a customer, commercial programs, and the military.
- o Stabilize the rate of technical change, simplify procedures, and reduce the traffic of decision demand upon Headquarters.
- o Develop future customers.

A. Subcontract Services Required by "Space Transportation" from the R&D Organizations

It would be naive to think that the Shuttle and its operation would not require substantial continuing research and development as experience generates either new demands or desirable improvements from a cost or safety point of view. To accomplish this the operational organization must have a formal channel, and be required, to call upon NASA's research and development elements for the necessary work on essentially a subcontract basis. This will assure that the proper people do the work and that an appropriate framework for financial control is maintained and monitored. A few examples of the activities or functions that the operational organization should obtain from the research and development elements of NASA are:

1. The creation of any new Shuttle transportation elements, the requirements for which should be defined by the operations organization based on transportation customer needs.
2. The engineering required for changes to improve reliability, safety, cost or performance, the requirements for which are similarly originated and defined by the operational organization.
3. System and component testing services, including the certification of new or changed components or systems.
4. The advisory support of development specialists on a consulting basis.
5. The establishment of a formal program for the continuing performance audit of flight and ground systems, including tracking, communications and data systems.

B. Space Transportation Services Provided to R&D Elements of NASA

The Panel suggestion that the operational Space Transportation System look to the scientists and engineers elsewhere in NASA for research and development is coupled with a similar recommendation that the R&D community of NASA look to the transportation service organization for the performance of transportation and operations tasks for all of NASA. This on a "subcontract" basis in order to implement a framework for monitoring functional, financial, and schedule performance. A few examples of these services are found in the operation of OSTS (Office of Space Transportation Systems) today and include further:

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1. The transport, or orbital placement, of payloads.
2. The orbital repair or retrieval of payloads.
3. The eventual maintenance of orbital facilities for manned or unmanned experiments.
4. Data delivery from orbital experiments for analysis by those responsible for the experiments.
5. Launch services and appropriate support for non-Shuttle systems.

C. A Framework for Successful Routine Operations

Last year's report by the ASAP commented upon the need for expanding its attention to the entire subject of logistics, payloads, and operations. These subjects, until the completion of two successful launches, have been transcended by the pressures of the research and development demands. With the production lead-times characteristic of small-batch highly specialized products a study which will lead to investment ranging from space engines and airframe components to the multitudinous system and accessary components is probably already overdue. The Panel is directing its attention to this operational phase and can be expected to require access to activities and developing programs in which its experience and expertise should be of value. The Panel looks forward to full cooperation from cognizant organization.

Maintenance and overhaul plans must first be developed in detail for KSC and VAFB and then, using these, such logistics elements as supply, manning, training, publications, and vehicle standardization can more logically fall into place. A range of

turnaround rates should be considered from the most optimistic to the pessimistic, the latter considering the possible grounding of one vehicle due to accidental damage or modification. The ground support equipment and requirements have no parallel in previous practice and matters affecting overhaul and in-service life arising from repeated launch degradation are in need of special study now. Until this most comprehensive planning is undertaken it will be difficult to maintain budgetary control in a program which has now to be very cost-conscious. Schedule reliability is the sine qua non to attract commercial and even military payloads and, in the view of some Panel members, is more likely to be affected around 1983-85 by parts shortages than by equipment or design failures.

In attempting to assess its own capabilities to review future Space Transportation Operations the ASAP produced a broad outline of functions that must somehow be fulfilled by a truly operational organization. Although many of these needs have no direct impact on safety they do have an impact on the routine nature of any transport system, and therefore a secondary but important impact on the recognition of hazards. At the rates of the orbital missions now planned, it will be absolutely essential that procedures stay consistent, changes be reduced to near zero, and that the launch teams be experienced, well trained, and have qualified spares at hand.

D. Prime Functions of Transport Operations

1. Planning and marketing

a. Planning for present market

b. Future payload and orbit needs (commerce, government, military)

c. Total traffic projection

d. Service cost projection

e. Service pricing policy recommendations

f. Selling of services

2. Engineering and operations

a. Definition of product improvement needs

b. Facility Planning

c. Logistics plans and operations

d. Support and procurement (spares, fluids, services)

e. Scheduling

f. Overhaul and maintenance

g. Base operations (launch and landing) support

h. Quality assurance

i. Cost control of transport system services

j. Payload services to customers

k. Training

3. Tracking, communications and data services

a. Routine support of operations

b. Payload communications and customer data service

c. System and data base, modernization requirements

d. Cost control of track, communication, data services

e. Training

IV. Continuing Activities of the Aerospace Safety Advisory Panel

A. Panel Membership

As noted in the executive summary, Panel membership to provide operational experience has been augmented by members:

John F. McDonald, Vice President Technical Services of TigerAir, Inc., the parent corporation for Flying Tigers. John F. McDonald served for a number of years as Vice President of Maintenance and Engineering, and as a director for the Flying Tiger Line. Previous to that, he directed all commercial customer support activities for the Lockheed California Company. He was educated as a mechanical engineer in England and served British Overseas Airways Corporation before coming to America.

Norman R. Parmet, recently retired Vice President of Engineering and Quality Assurance for TransWorld Airlines. Norm Parmet has served TWA since 1947 in a number of roles including power plant development and as Vice President for New Equipment Development as well as Logistics Management. He was graduated as a mechanical engineer from Drexel Institute of Technology.

Plans for 1982 include a replacement for Dr. Seymour C. Himmel, whose term of appointment as a member was completed in 1981, and has been retained as a consultant for one year. It is hoped that his replacement will bring to the Panel similar expertise in the power plant field, particularly in hypergolic systems which now appear to require concentrated attention. During the year, it is also hoped that the Panel can be augmented by experience in the architecture of modern control systems.

B. Informal Subgroup Activities

It is expected that informal subgroups of the Panel will be formed to follow certain specific activities. In the view of ASAP the following appear to be particularly important:

1. An assessent of any continuing technical audit function instituted by the R&D program management. Such concentrated technical assessment was responsible for uncovering sneak circuit hazards prior to STS-2, and should be continued seeking improvements in safety and reliability for the electrical, electronic, and computational systems.
2. Suggested in this report is an audit of the systems redundancy concepts for the many Shuttle subsystems. The Panel believes that major simplification is possible which could benefit cost, performance, and safety. If alternative concepts cannot be accommodated within budget and schedule constraints, they can be incorporated in subsequent block buys of improved transportation systems and should be initiated now.
3. If NASA reorganizes to include an independent "operations" entity, a safety audit team should review the transition of procedures from R&D to operations. The criticality of this transition and

the obvious need for massive procedures simplification suggest that a continuing audit will be required. The ASAP will assess this activity or its equivalent.

C. Plans for 1982

The Panel has operated in the mode of fact finding by individual members or small informal groups visiting the appropriate centers and contractors. During the year the Panel compares notes and communicates with top NASA management. It is the Panel's intention to continue in this fashion, probably with an increased number of times when the entire Panel participates in the readiness activities prior to STS-3,-4,-5, and -6. It is planned to follow Orbiter 099 and particularly note the impact on operational procedures with two Orbiters being readied for launch in parallel.

The actual dates and locations of Panel fact-findings are to be keyed to the Shuttle major milestones recognizing the increased activity planned for Shuttle payloads with accompanying hardware and software impacts. Payloads include OSSA-1, Spacelab, Tracking & Data Relay Satellite System (TDRSS), and the probable incorporation of the Manned Maneuvering Unit (MMU). In addition to such payloads it is expected that the Panel will review concepts for upper stage propulsion systems and any early proposal for basic Shuttle performance improvements such as light weight SRB's or a light weight Expendable Tank.

KSC intends to have a self-sufficient Shuttle Processing Contractor when the Space Shuttle becomes operational. It is of interest to the Panel that such a transition take place without any loss of emphasis on ground and flight safety.

Although the Panel's efforts directed at programs other than the Space Transportation System require less concentrated attention they are equally important from the viewpoint of NASA's public accountability regarding their safety. In creating the Panel, Congress clearly envisioned this broader responsibility. These areas include aeronautics programs (manned and unmanned), unmanned space vehicles, and tracking and data acquisition as it affects safe mission operation. In times of great budget stringency, such as the present, it is especially important that safety considerations not be permitted to erode as program managers stretch their highly-constrained program resources to achieve desired objectives.

The following is a sample of those areas that are of continuing concern to the Panel:

1. Other Flight Operations: The concentration on the early Shuttle flights has diverted the Panel's attention from flight operations at Ames, Dryden, and Langley. Past Panel experience has shown that NASA controls the safety of test operations most carefully at these centers and the record shows good performance. Several accidents involving flight in aircraft not operating under strict NASA test control suggest that reviews should be made of procedures

whereby NASA personnel are exposed to hazard in less than controlled test conditions. The Panel plans to assess policies at these centers and review the control of such activities.

2. Pressure System Recertification: It has been suggested that the ASAP review how NASA certifies the pressure vessels and systems at its many facilities and how it maintains such certification. The Panel believes that its primary purpose is to concentrate on the safety aspects of manned flight and on the safety implications of operating unmanned systems rather than on what is normally called industrial safety. It is the Panel's assumption that industrial safety is a center function which has been successfully fulfilled through the years and will not address this important subject unless instructed to do so by the Administrator.

3. Contracting Out: Budget pressures and the efforts to provide more flexibility in manpower levels as operational efficiencies are achieved suggest that many more program operations be placed under contract. This does not relieve NASA of the supervisory responsibility. The inadequate compensation schedule of the Federal Government for top level managers makes it increasingly difficult to maintain a management team of highest technical and managerial competence. The exodus of key NASA

personnel during the past year provides striking confirmation of this grave problem. Although the Administration and Congress recently collaborated in achieving a small increase in the Federal pay cap, the problem is still unresolved and likely to remain so under present extreme budgetary pressures. The Panel believes it is essential to point out that loyalty and dedication to NASA -- a hallmark of the Nation's space program to date -- can only go so far in substituting for a pay schedule that is truly competitive with private industry. In this environment it is essential that contractors be chosen who can bring the maximum experience to the program.

4. Hydrogen Safety Standard: The Panel suggestion of a future hydrogen-oxygen auxiliary power system and the use of this fuel combination for on-Orbit reaction control systems imply different safety standards than are currently used for the fuel cells. In addition, the possible use of the Centaur as an upper stage in the Orbiter and the emerging potential of LH_2 as an aircraft fuel all indicate that the Panel should review existing safety standards for handling hydrogen in flight vehicles and in ground facilities for storage and service. The Panel will initiate such a review.

5. NASA-Air Force Coordination: ASAP activities have not included any reviews of Air Force launch facilities or simulation activities. Much could be learned from new approaches and it is assumed that NASA is fully familiar with Air Force activities. The ASAP will rely on instructions from the Administrator before making any requests to the Air Force for information.

V. System Assessment and Hardware Concepts to Improve Operating Safety and Performance

The two successful flights of the Columbia have demonstrated that the Shuttle can perform as a space launch vehicle and that the Orbiter can be reused -- an outstanding technological achievement. Even the most enthusiastic proponent of the Shuttle would not, however, claim that its present design can achieve the level of operational reliability (and hence safety) required for economical and "routine" transportation to and from space. There are Shuttle subsystems and components that, although acceptable for use during a flight test program and early transiton to operations, are not optimum for routine operational use. Even though the flight test program has just begun, it is optimistically planned to be nearly complete with only two more flights. It is not too soon to begin the process of study, analysis, design, and planning to improve the operating safety, cost, and performance of the Shuttle by reassessing it essential elements.

A two-part effort is required to achieve the improvements desired. The first part is a systems-engineering effort -- a reexamination of the consistency with which systems design principles have been used. The second part will necessarily address new designs or design modifications of specific hardware to achieve simplification, improved safety, and enhanced performance.

A. Redundancy Review

The Shuttle employs redundancy in its systems to achieve high reliability and thus safety. The degree of redundancy employed, however, varies from subsystem to subsystem. For example, in the flight control system the main computers are quadruple-redundant with a backup computer (and software) and a spare computer that the crew can install. The hydraulic system that provides the power to move the Orbiter flight control surfaces is triple-redundant in pumps and hydrazine-fueled turbines, it is not redundant for each main engine control and it is double-redundant for each Solid Rocket Booster. The hydraulic actuators that move the surfaces are simplex with duplex servo-valves. The main engine thrust controllers have dual computers and a "lock-up" feature in the propellant valve system designed to retain thrust level in the event of a total controller failure.

Similar diversity in the use of redundancy exists in other vehicle systems. This raises the question of whether safety concepts have been employed in a consistent manner in the Shuttle systems design.

It would be advisable, therefore, to establish an "audit" team of experienced R&D systems-engineers to review the design of Shuttle systems to ascertain whether consistent safety/reliability concepts and criteria have been employed in the design. Where such consistency does not exist, the team should recommend design changes to provide such uniformity. At a minimum, this team should review the following:

- o Hydraulic power systems
- o Flight control system architecture
- o Main engine thrust control system
- o Main and backup computer systems (including programming)
- o Electric power system (including fuel cells)
- o Communication and data systems

B. Specific Systems

There are a number of systems which can be improved by redesign or design modification. The Panel believes that the following systems deserve attention in approximately the order listed.

1. Landing gear: At present the margin of safety of the gear for the originally-established design conditions is low. In addition, the design is such that should a tire fail, its mate (almost certainly) would also fail -- a potential hazard. Redesign of the gear incorporating a larger number of wheels than the current configuration would improve both the load-carrying capacity and enhance the operational safety of the system. Experience has shown that debris from the wheel ground interface has damaged the thermally-protected Shuttle surface. In any redesign, an effort should be made to divert such debris away from contact with the Shuttle -- spray ribs on the tires might be helpful.

2. Solid Rocket Boosters: At present, the gimballed SRB nozzles provide part of the control authority during ascent. Each SRB is equipped with a pair of hydraulic power units for the gimbal actuators. These hydrazine-fueled turbopump systems are complex and heavy. It was prudent to provide this control capacity for the early flights as it is not possible to predict with suitable accuracy the control moments required during ascent in the absence of flight data for the unique configuration of the Shuttle. Now that flight data are becoming available, this system should be examined carefully to determine whether all the control authority provided is necessary or whether the SSMEs alone can provide all that is needed. In the latter event, the SRB auxiliary power units could be eliminated and relatively slow-acting electric actuators substituted to provide a programmed pitch profile during boost as the center of gravity changes. The savings in weight, complexity, and safety should be significant.

Additional performance improvement might be obtained by employing a composite material for the SRM case instead of the metal now used. This possibility should be studied thoroughly. Finally, the booster recovery system should be reexamined to see if it cannot be made substantially more simple than it is now.

3. Cockpit and Crew Station Design: The crew has myriad duties to perform in the cockpit. The workload can, at times, approach the saturation point. During STS-2, the crew workload, aggravated by sensor anomalies and the fuel cell problem, became so heavy that the crew fell a couple of hours behind in the "Crew Activity Schedule." The many sensor and transducer indications of "redline" approach or penetration, thermostat malfunctions, etc., raise the question of whether the qualification and certification for such instrumentaton is adequate. A thorough scrubdown of the cockpit displays, controls & switches, and the reliability of the sensors furnishing the information is indicated. In addition to assuring that the crew is furnished needed and valid data it is probable that a combination of automation and simplification would make Shuttle flight an easier task for the crew and thus safer.

During discussions with the flight crew of STS-1 concern was noted over the design of the emergency egress systems after flight STS-4 when the ejection seats are scheduled to be removed. The entire Panel did inspect the mockups available at JSC and concurs with the crew comments that an important safety concern exists. Of particular import is crew egress after ditching. The Panel heard an outline for future study at JSC and reviewed what was known of previous tests. It appeared to the Panel that substantially more effort to determine likely scenarios

and their consequences is in order. Although ditching may be extremely remote this does not relieve NASA of the responsibility to provide the crew with as great a chance to survive as possible.

4. SIP Material Improvement: One of the problems of the Orbiter thermal protection system is the hysteresis in the stress-strain relationship in the strain isolation pad (SIP) material. A new version of the material with organized fiber orientation and consistent adhesion to the structure and the tile, rather than the random orientation of fibers in the present material, offers the promise of substantially reduced, if not eliminated, hysteresis. This development should be pursued actively.
5. Flight Control: At present, each control surface of the Orbiter is a single structure driven by a single actuator. Such simplex configurations are undesirable and are avoided in modern transport and military aircraft. Two alternative configurations have been employed in transport aircraft. The first is to employ a set of smaller independent control surfaces and actuators in place of a single large surface and actuator. The second is to use multiple actuators in parallel or in tandem on a single surface. Either approach enhances operational reliability and safety and these should be studied for possible incorporation in the operational Shuttle design. The Orbiter shares the problem of directional instability at high mach numbers with most

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modern supersonic fighters due to the vertical tail being blanked by the shock waves eminating on the forward surfaces of the vehicle. This has resulted in changes in the computer handling of the reentry maneuvers and the use of yaw thrusters nearly down to Mach 1. Since a more direct reference system has already been designed and qualified it would seem prudent to utilize this Shuttle Entry Air Data System (SEADS) to determine whether such a reference would help to produce more stable reentries and reduce the demand on use of yaw jets at low mach number.

6. Common Non-Hypergolic Propellants: Other than for the main propulsion and booster systems, the Shuttle employs hypergolic propellants for auxiliary propulsion and power generation. Hydrazine and Nitrogen-Tetroxide are the propellants employed for these purposes. Both are toxic, incompatible with many Orbiter materials with which they may come into contact inadvertently, and are difficult to handle. None of these attributes are conducive to "routine" use and continuing problems involving safety and schedule can be expected. During both STS-1 and STS-2 preparation and turnaround, the presence of such materials limited access to the Shuttle, and during preparations for STS-2 there were two incidents involving spills of these propellants. Both these incidents and the lack of access impacted the preparation schedule for the Orbiter.

It would be advantageous if the use of these propellants could be avoided. The propellants for the SSMEs, hydrogen and oxygen, albeit cryogenics, could be used for the Orbital Maneuvering System (OMS), Reaction Control System (RCS), and APU systems without many of the operational problems of the hypergolics. There have been significant advances in the technology of hydrogen and oxygen for ancillary systems applications since the decisions were made to use hypergolics in the Orbiter a decade ago. A serious review of the possible use of H_2 and O_2 should be made.

The recommended studies and redesigns should be established as an overall program for the improvement of the Shuttle and its further development as an operational transportation system. The Panel fully recognizes the budget and schedule pressures that inhibit incorporation of changes even if many advantages accrue. The Panel also recognizes the hazard of change itself and its impact on procedures and the performance of even well-trained personnel and supervision. Thus, the concepts suggested are only for the purpose of indicating areas of attention for any planned improvement program or for defining the configuration for a future block purchase of an advanced transportation system.

VI. Conclusions

The Aerospace Safety Advisory Panel commends and congratulates all of NASA and its contractors for the historic flights STS-1 and STS-2. A task that verged on the impossible has been accomplished with the world privileged to watch every step. The success of these missions tempers any suggestions for improvement but, impressive as the development has been, the aim of the program is routine operation. In this spirit the ASAP offers these suggestions based on its evaluation through 1981.

A. To achieve true operating safety, regularity, and minimum practical cost, the organization of efforts between the R&D community and any transportation service organization should be clearly separated. The transportation service organization should assume responsibilities analagous to commercial airline managements. This includes marketing of its services to government agencies, and to commercial as well as international entities needing space transportation. Implied in "operations" is the planning and acquisition of prime hardware and spares, maintenance, certification of procedures, training, creation of requirements for future development including performance improvement and the responsibility to determine readiness for all missions and the fulfillment of these missions safely.

B. The Panel suggests a technical audit of the application of redundancy concepts to Shuttle systems. From design reviews the ASAP believes that many systems can be simplified

with both safety and cost benefits while other systems should be backed up further for operational safety. ASAP candidates for such a review are:

1. Total hydraulic power system -- both for solid rocket and Shuttle control -- including the use, numbers, configuration and location of auxiliary power plants.
2. Basic control system architecture for aerodynamic controls, main engines, SRBs, and Orbiter control motors.
3. Control of main engine thrust.
4. Computer logic in normal and backup modes with a special effort to standardize programming for operations to prevent flight-to-flight and particularly last minute reprogramming.
5. Electric power systems
6. Avionics and communication

C. The current development state of the space transportation hardware suggests that a number of concept changes may improve operational safety, reliability and costs. In priority, the ASAP suggest:

1. Investigating a main landing gear with more than two wheels per side and devices to avoid gravel "spray" which damages thermal protection tiles.
2. Reviewing the need for control of SRB nozzles to maneuver the total Shuttle vehicle. As performance

of the control system evolves, it may be possible to revert to a programmed "trim" system on SRBs. In addition, when investigating lighter cases (composites) the separation and recovery systems should be reanalyzed to simplify.

3. The automation and simplification of cockpit and routine crew duties, along with improved reliability of sensors.
4. Review of the hysteresis of SIP. Repeated missions will require SIP that is less susceptible to dimension changes with steady and vibratory loads.
5. Reassessment of flight controls concepts. It is suggested that multiple control surfaces or drives be considered.
6. Investigate non-hypergolic fuel and oxidizer for orbital boost, on orbit control motors, and APUs.

D. For the remaining R&D flights, it is suggested that a "redline" audit be made of limits that should not be exceeded for "ready to launch." It is poor practice to set conservative limits and then bypass them at last minute launch readiness conferences.

For 1982 the ASAP plans to follow the developing operational transportation program to review hardware changes, procedural changes, and the progress in clarifying the duties and responsibilities of any new operational organization. The review of 1982 scheduled flights, their readiness and performance, will be a primary ASAP activity.

In addition, the ASAP plans to revisit non-Shuttle flight activities at NASA centers both support and test. Finally, in 1982 the ASAP plans to review concepts and hardware for Shuttle payloads and upper stages since many of the unique mission equipment items introduce potential operational hazards to both individual crew members and the Shuttle itself.

APPENDIX I

Name and Affiliation	Appointment Ends
Willis M. Hawkins Senior Advisor Lockheed Corporation Burbank, CA 91520	September 1, 1988
Richard H. Battin Charles Stark Draper Lab. Cambridge, MA 02139	April 7, 1986
Lt. Gen. Leighton I. Davis USAF (Ret.) Albuquerque, NM 87123	December 19, 1983
Herbert E. Grier Consultant La Jolla, CA 92037	January 18, 1985
Ira Grant Hedrick Presidential Assistant for Corporate Technology Grumman Aerospace Corporation Bethpage, NY 11714	November 17, 1985
Seymour C. Himmel Consultant Lakewood, OH 44107	December 23, 1981 (Consultant status through 12/82)
John F. McDonald Vice President-Technical Services TigerAir, Inc. Burbank, CA 91505	June 15, 1986
Norman R. Parmet Consultant Fairway, KS 66205	1988 (in process)
John G. Stewart Manager, Office of Planning and Budget Tennessee Valley Authority Knoxville, TN 37902	April 14, 1986
Walter C. Williams NASA Chief Engineer Washington, D.C. 20546	Ex-Officio Member
Gilbert L. Roth NASA Headquarters Washington, DC 20546	Staff Director
Susan Webster NASA Headquarters Washington, DC 20546	Advisory Committee Assistant

ADDITIONAL NASA REPORTS FOR THE RECORD

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

JUN 10 1981

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

Dear Mr. Chairman:

This letter is in response to the Committee views on NASA Advisory Committees set out in House Report 97-32, (page 23 et seq.) accompanying H.R. 1257, the NASA Authorization Bill for Fiscal Year 1982.

NASA's Advisory Committee structure is established in accordance with the Federal Advisory Committee Act, P.L. 92-463, and operates under the provisions of NASA Management Instruction 1150.2E, dated June 21, 1979. NASA Management Instruction 1156.34A, dated October 1, 1979, sets forth the Charter of the NASA Advisory Council (NAC) and its related standing committees. Copies of both management instructions are enclosed. Under the provisions of the Federal Advisory Committee Act, an advisory committee's function is only advisory and its establishment is for the purpose of obtaining advice or recommendations for the executive agency. The Act requires the agency to keep records on the operation and activities of its committees and requires periodic reporting of such activities.

Mr. Chairman, your report contains several requests relating to the NASA Advisory Council and its committees. With regard to your request for an annual report to the Congress summarizing recommendations made to the Administrator by such committees, we would be pleased to provide this material. Currently, NASA prepares annual reports for the General Services Administration on the activities of its advisory committees and copies of all committee reports are filed with the Library of Congress. We will see to it in the future that such NAC materials are made available directly to your Committee.

The Report also recommends that the committees be able, at least in part, to set their own agenda and terms of discussion; this has frequently been the case, subject only to NASA approval of the agenda, as required under the Federal Advisory Committee Act. We will continue this practice.

The Federal Advisory Committee Act provides that agency advisory committees are advisory to the agency under which they are chartered. As such, their recommendations are directed to that agency. Actions to be taken and policy expressed on matters upon which such committees report or make recommendations are to be made solely by an agency officer. With the exceptions set forth in the Government in Sunshine Act 5 U.S.C. 552b(c), meetings of the advisory committees are open; Congressional staff do attend from time to time, and we will encourage your staff to attend future meetings. In addition, the Chairmen or members of the various committees are available to testify before your Committee in their individual capacities, so that their views may be freely aired as you wish.

I would be happy to discuss this with you further if you so desire.

Sincerely,

A. M. Lovelace
for Acting Administrator

Enclosures

cc:
Honorable Larry Winn, Jr.
Honorable Ronnie G. Flippo
Honorable Harold C. Hollenbeck
Honorable Dan R. Glickman
Honorable Barry M. Goldwater, Jr.

NASA
Management
Instruction

NMI 1150.2E
Date June 21, 1979

Responsible Office: L/Office of External Relations

Subject: ESTABLISHMENT, OPERATION, AND DURATION OF NASA ADVISORY COMMITTEES

*1. PURPOSE

This Instruction sets forth policies, standards, and procedures for the establishment, operation, and duration of NASA advisory committees, in implementation of the Federal Advisory Committee Act and OMB Circular No. A-63, Revised. It also specifies the requirements for reporting annually on the use or termination of such committees to the General Services Administration (GSA).

2. APPLICABILITY

This Instruction is applicable to NASA Headquarters and Field Installations.

3. AUTHORITY

a. Section 203(c)(7) National Aeronautics and Space Act of 1958 (42 U.S.C. 2473(c)(7)).

b. The Federal Advisory Committee Act (Public Law 92-463, October 6, 1972, 5 U.S.C. App., Section 1, et seq.).

c. Government in the Sunshine Act, 5 U.S.C. 552b(c).

d. Executive Order 11769, dated February 21, 1974.

e. OMB Circular No. A-63, Revised, dated March 27, 1974, as amended.

* f. GSA Memorandum, dated November 8, 1978.

4. DEFINITION

For the purposes of this Instruction, the term "advisory committee" means any committee, board, commission, council, conference, panel, task force, or other similar group, or any subcommittee or other subgroup thereof, that is not composed wholly of full-time Federal Government employees, and that is established or utilized by NASA in the interest of obtaining advice or recommendations.

* Changed by this revision.

5. SCOPE

The provisions of this Instruction do not apply:

a. to advisory committees established by statute, to the extent that such statute specifically provides that the committee will not be subject to the provisions of the Federal Advisory Committee Act, or to regulations promulgated under that Act;

b. to persons or organizations which have contractual relations with NASA. For example, this Instruction does not apply to such organizations as the National Academy of Sciences and its various committees;

c. to committees or similar groups whose primary function is operational. Where such a group provides some advice to NASA, but its advisory function is incidental to and inseparable from its operational function, this Instruction does not apply. However, if the advisory function is separable, the group is subject to this Instruction to the extent it operates as an advisory committee;

d. to any civic group whose primary function is that of rendering a public service with respect to a Federal program, or that of presenting its views on subjects of local interest to NASA officials; and

e. to any State or local committees or similar group established to advise or make recommendations to State or local officials or agencies.

6. POLICY

a. The number of advisory committees established or utilized by NASA will be kept to the minimum necessary. Such committees will be established or continued in existence only when they are determined to be essential and will be terminated if they are no longer active or carrying out the purpose for which they were established.

b. No advisory committee shall be established by NASA, or continued in existence, except in accordance with the provisions of this Instruction.

c. Unless otherwise specifically authorized by statute or Presidential directive, no advisory committee shall be used for functions which are not solely advisory. Determinations of actions to be taken and policy to be expressed with respect to matters upon which such a committee advises or makes recommendations shall be made solely by a full-time NASA employee.

7. ESTABLISHMENT OR UTILIZATION OF ADVISORY COMMITTEES

* a. Unless its establishment is effected or authorized by statute or Presidential directive, a NASA advisory committee shall be established only if the Administrator or designee specifically determines as a matter of formal record that such establishment is in the public interest in connection with the performance of duties imposed upon NASA by law.

b. Except for advisory committees established by statute or Presidential directive, committees not established by NASA will be utilized for the purpose of obtaining advice or recommendations only with the approval of the Administrator, and after provision has been made for compliance with applicable provisions of the Federal Advisory Committee Act and OMB Circular No. A-63, Revised.

8. PROCEDURES FOR ESTABLISHMENT AND RENEWAL OF ADVISORY COMMITTEES

a. The official recommending the establishment or renewal of a NASA advisory committee shall submit to the Advisory Committee Management Officer a proposal to that effect, which shall indicate as a minimum: (1) the nature and purpose of the proposed committee, and a statement why its functions could not be performed within NASA or by an existing advisory committee; (2) the relationships of the committee, if any, to other NASA organizational elements and advisory groups, or to other Government agencies, and the planned methods for communicating with them; and (3) the proposed membership of the committee by names and/or examples, indicating how such proposed membership will achieve an appropriate balance.

b. The Advisory Committee Management Officer will, after appropriate staffing, submit the proposal to the Administrator for approval.

c. Upon approval by the Administrator, the Advisory Committee Management Officer will consult with GSA by letter, enclosing a draft of the proposed charter, make the determination referred to in Paragraph 7a hereof, and will arrange for publication of a notice of such determination in the Federal Register. Such notice must be published at least 15 days prior to the date of approval of the committee Charter, unless the GSA Committee Management Secretariat authorizes, for good cause, a shorter interval, and shall include a description of the nature and purposes of the committee.

* Changed by this revision.

d. Subject to coordination with the appropriate NASA officials, the Advisory Committee Management Officer will thereafter approve the Charter for the committee. Copies of such Charter will be filed with the cognizant committees of Congress and furnished to the Library of Congress, as provided for under Paragraphs 10a(17) and 10b hereof. The committee shall not meet or take any other action until the Charter has been thus filed.

e. The Advisory Committee Management Officer shall determine whether any proposed advisory committee activity falls within the scope of this Instruction.

* f. Working groups whose primary function is operational and which would not fall under the provisions of this Instruction may be established by the Program Associate Administrators as well as the Associate Administrator for Management Operations and the Associate Administrator for External Relations with the advice of the Office of the General Counsel and the Advisory Committee Management Officer.

9. DURATION OF ADVISORY COMMITTEES

* a. Unless its duration is otherwise fixed by statute or Presidential directive, an advisory committee shall terminate not later than two years from the date of its establishment unless the Administrator or designee makes a formal determination not more than 60 days prior to the date of its scheduled termination that its continued existence is in the public interest. A like determination by the Administrator or designee shall be necessary not more than 60 days before the end of each subsequent two-year period to continue the existence of such committee thereafter. In connection with making such a determination, the procedures prescribed under Paragraph 7a of OMB Circular No. A-63, Revised, will be followed.

b. Subject to coordination with the appropriate NASA officials, a new committee charter will be approved by the Advisory Committee Management Officer and filed with the cognizant committees of Congress on each occasion that a committee's duration is extended. Until the new Charter is filed, the committee will not meet or take any action.

c. In the case of the Aerospace Safety Advisory Panel, which was established by statute to have an indefinite duration, the determination under subparagraph a above is not required, but a new Charter shall be approved and filed at least every two years.

* Changed by this revision.

10. ADVISORY COMMITTEE CHARTERS

a. The NASA official sponsoring an advisory committee will be responsbile for preparing the committee Charter, and any renewal Charter. Such Charter shall, as a minimum, contain the following information:

(1) the committee's official designation;

(2) a statement that the Administrator's designee has determined as a matter of formal record that the establishment, or continuation, of the committee is in the public interest in connection with the performance of duties imposed upon NASA by law;

(3) the committee's objectives and the scope of its activities;

(4) a description of the duties for which the committee is responsible and, if such duties are not solely advisory, a specification of the authority for such functions;

(5) the period of time necessary for the committee to carry out its purposes;

(6) the NASA official or officials to whom the committee reports or is responsible;

(7) the office responsible for providing necessary staff supporting services for the committee;

(8) the interrelationships, if any, of the committee with other NASA officials or organizations or committees;

(9) membership, and related matters, as provided under Paragraph 11e hereof;

(10) rules for the approval of committee agenda and conduct of meetings;

(11) procedures for establishing formal or informal subcommittees or other subgroups;

(12) notice of requirements for avoidance of conflicts of interests by non-Government members of the committee;

* (13) the estimated annual operating costs in dollars and staff-years for such committee;

* Changed by this revision.

(14) the estimated number and frequency of committee meetings;

(15) the committee's termination date;

(16) the responsibility for maintenance of committee records;

(17) notice of the requirement that a copy of the Charter shall be filed with the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science and Technology before the committee may meet or take any other action; and

(18) the date by which the Charter shall be filed.

b. A copy of the Charter for each advisory committee will also be furnished to the Library of Congress, as provided for under Paragraph 6c(2) of OMB Circular No. A-63, Revised.

11. MEMBERSHIP OF ADVISORY COMMITTEES

a. Membership on NASA advisory committees shall be limited to the number of qualified persons required to carry out the prescribed functions of the committee.

b. Non-Government members of advisory committees will be selected on the basis of professional competence and not as representatives of the organization with which they are affiliated. Government members may be selected either on the basis of professional competence or as representatives of the department or agency by which they are employed.

c. The membership of an advisory committee shall, to the extent practicable, be fairly balanced in terms of the professional perspectives represented and the committee's functions. In selecting members, an effort should be made to include individuals representing different points of view and types of employment--e.g., university, industry, etc.

d. New selections should maintain the degree of professional competence needed in specific committee assignments without discrimination on the basis of race, color, religion, sex, national origin, age, or handicap. Affirmative plans shall be developed to identify women and minority candidates who are qualified to serve on NASA advisory committees.

* e. The Administrator shall be consulted before any contact is made with any individuals being considered for the Chair or as members of such advisory committees as may be specified by the Administrator to the Advisory Committee Management Officer.

* f. The Charter establishing or continuing a committee shall designate a Chair, the committee members, and an Executive Secretary, who shall be a full-time NASA employee. Dual or rotating chairs will not be authorized, unless the Administrator determines that such an arrangement is required.

12. RESPONSIBILITIES OF THE COMMITTEE CHAIR AND EXECUTIVE SECRETARY

* a. Responsibility for the conduct or supervision of all assigned activities of an advisory committee, including the calling of meetings and preparation of the agenda, shall be vested in the Chair.

* b. The Executive Secretary of a committee is responsible for (1) facilitating communication among the Chair and members, and between the committee and NASA management; (2) assisting the Chair with the preparation of the notice of a committee meeting and the agenda for it; (3) obtaining timely approval of such notice and agenda by the Advisory Committee Management Officer; (4) providing advance information on meetings to committee members; (5) providing staff support, including the preparation and distribution to committee members and within the Government of the records of committee proceedings, reports and other documents; and (6) ensuring proper documentation in connection with the appointment or reappointment of committee members.

13. RULES GOVERNING ADVISORY COMMITTEE MEETING

The following rules will govern meetings of NASA advisory committees:

a. No meeting shall be held except with the advance approval of the Advisory Committee Management Officer, and on the basis of an agenda approved by such Officer, after coordination with the appropriate NASA officials. The agenda shall list the matters to be considered at the meeting and shall indicate which portions will be open, and which closed, to members of the public. When only part of a meeting is to be closed, the agenda shall be arranged, wherever practicable, to facilitate attendance by the public at the open portion of the meeting.

*Changed by this revision.

93-418 O—82——88

b. Committee meetings shall be open to members of the public, except to the extent that the Advisory Committee Management Officer, in approving the agenda for the meeting, determines that the meeting or a portion of such meeting may be closed to the public in accordance with the Government in the Sunshine Act (5 U.S.C. 552b(c)(1) through (10)).

c. An advisory committee which seeks to have all or part of a meeting closed on the basis of the Government in the Sunshine Act exemptions shall notify the Advisory Committee Management Officer at least 30 days in advance of the scheduled date of the meeting. The notification shall be in writing and shall specify the reasons why all or part of the meeting should be closed.

* d. If the Advisory Committee Management Officer finds the request to be warranted and in accord with the policy of the Federal Advisory Committee Act, such Officer will make a determination in writing that all or part of the meeting should be closed, stating the specific reasons therefore. Such determination will be reviewed in advance by the General Counsel or designee, and shall be made available to the public upon request.

* e. Except when the Administrator, GSA, determines that public notice of a committee meeting would be inconsistent with national security (as provided for in paragraph 8b(4) of OMB Circular No. A-63, Revised), a notice of each committee meeting will be published in the Federal Register, and to the extent practicable provided by other means, such as press releases or notices by mail. The Federal Register notice will be published at least 15 days before the date of the meeting, except where an emergency situation necessitates shorter advance notice, in which event the notice will indicate the reasons for the emergency exception. The notice shall include the name of the committee, the date, time, place and purpose of the meeting, a summary of the agenda, and the extent to which the meeting will be open to the public. If all or part of a meeting is to be closed, the notice will indicate the basis for closing it. The notice shall be submitted to the Committee Management Officer no later than 30 days in advance of the meeting date.

f. When all or part of a meeting is closed, the matters discussed shall not be disclosed except to members of the committee, the committee staff, or NASA employees.

*Changed by this revision.

However, the committee shall issue a report at least annually, setting forth a summary of its activities and related matters which are informative to the public consistent with the policy of the Freedom of Information Act. Notice of availability of such annual report shall be published in the Federal Register no later than 60 days after its completion. The notice shall include instructions which will allow the public access to the report.

g. Committee meetings which are open to the public shall be held at a reasonable time and at a place that is reasonably accessible. The size of the meeting room shall be reasonable, considering such factors as the size of the advisory committee, the number of members of the public who could be expected to seek to attend the particular meeting, the number of persons who attended or sought to attend similar meetings in the past, and the resources and facilities available to NASA.

* h. Any member of the public who wishes to do so shall be permitted to file a written statement with the committee, before or after the meeting. To the extent that the time available for the meeting permits, interested persons may be permitted by the committee Chair (or the person presiding) to present oral statements at the meeting, but the Chair may establish procedures requiring such persons to obtain advance approval for such participation. Questioning of committee members or other participants will not be permitted except in accordance with procedures established by the Chair.

* i. Committee meetings shall be conducted in the presence of the Executive Secretary, or another specifically designated full-time NASA employee, who will be authorized and required to adjourn any meeting whenever such NASA employee considers adjournment to be in the public interest, and who will report such action to the Administrator.

* j. Detailed minutes shall be kept of each advisory committee meeting. The minutes shall include: the time and place of the meeting, a list of advisory committee members and staff and agency employees present at the meeting; a complete summary of matters discussed and conclusions reached (except to the extent the matters were discussed in closed session, in which event the provisions of subparagraph f above shall apply); copies of all reports received, issued, or

*Changed by this revision.

approved by the advisory committee; a description of the extent to which the meeting was open to the public; and a description of public participation, including a list of members of the public who presented oral or written statements and an estimate of the number of members of the public who attended the meeting. The Chair of the committee shall certify to the accuracy of the minutes.

k. Advice or recommendations of a committee shall be given only with respect to matters covered in the minutes of the committee's proceedings.

l. Committee inspection trips to NASA or other Government installations, or to contractors' facilities, will not constitute a committee meeting.

14. ADVISORY COMMITTEE RECORDS

a. All records and files of an advisory committee will be maintained by its Executive Secretary. Such records will include agenda, transcripts or minutes of meetings, analyses, working papers, drafts, studies, reports and any other documents or appendices thereto which were made available to or prepared by or for the committee.

b. Subject to the provisions of 5 U.S.C. 552 (the "Freedom of Information Act"), committee records shall be available for public inspection and copying, at a single location designated by the Executive Secretary until the committee ceases to exist. Requests by members of the public for access to or release of committee records will be handled in accordance with the provisions of NMI 1382.2.

c. The Executive Secretary will file at least eight copies of any report made by the committee with the Library of Congress. Copies of other committee records will also be filed with the Library, to the extent required by regulations of the Office of Management and Budget.

d. At such time as an advisory committee ceases to exist, its records will be retired in accordance with the provisions of the NASA Records Disposition Handbook (NHB 1441.1).

15. ADVISORY COMMITTEE MANAGEMENT

* a. The Associate Administrator for External Relations is designated as NASA Advisory Committee Management Officer,

* Changed by this revision.

and as such will exercise the authority and carry out the responsibilities assigned by this Instruction. Such Officer will perform such other duties in connection with advisory committees as may be necessary to exercise effective control over their management and use, including the issuance of further directives and instructions as needed and shall maintain information on the nature, functions, and operations of each advisory committee, and, in a single location, a complete set of the Charters for all committees, and copies of annual reports issued by such committees.

* b. The Advisory Committee Management Officer shall also be responsible for preparing and submitting the annual report required by Section 6(c) of the Federal Advisory Committee Act (as referred to in Paragraph 9 of OMB Circular No. A-63, Revised), and, in coordination with the appropriate NASA officials, for conducting the annual review required by Section 7(b) of the aforesaid Act (as referred to in Transmittal Memorandum No. 5, as amended, of OMB Circular No. A-63, Revised).

* c. The Advisory Committee Management Officer shall be responsible for the preparation of the annual report on closed meetings referred to in subparagraph 13f of this Instruction and for publishing notice of the availability of this report in the Federal Register, as required by Section 10(d) of the Federal Advisory Committee Act and Paragraph 8d(3) of OMB Circular No. A-63, Revised.

* d. The Advisory Committee Management Officer shall be responsible for submission of information for updating the data base of the GSA Committee Management Information System. In accordance with GSA Memorandum of November 8, 1978, Key Punch Data Forms will be completed for each new or reestablished committee and for all changes of status (renewal, merger, termination, etc.) and submitted to GSA within 10 days following the filing of the Charter.

16. PAYMENT OF TRAVEL EXPENSES

The amount of travel expenses authorized for payment to members of an advisory committee, to staff members thereof, or to consultants thereto, shall be governed by the provisions of Paragraph 11 of OMB Circular No. A-63, Revised, Transmittal Memorandum No. 4, dated February 5, 1976, which clarifies paragraph 11, except in the case of members of the Aerospace Safety Advisory Panel, whose expenses are governed by Section 6, NASA Authorization Act, 1968 (42 U.S.C. 2477).

* Changed by this revision.

*17. CANCELLATION

NMI 1150.2D, dated March 11, 1977.

Administrator

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SDL 1

* Changed by this revision.

NASA
Management
Instruction

NMI 1156.34A
Date October 1, 1979

Responsible Office LB/Management Support Office

Subject: NASA ADVISORY COUNCIL AND RELATED COMMITTEES

1. PURPOSE

This Instruction sets forth the Charter for the NASA Advisory Council and its related standing committees.

2. AUTHORITY

a. The Federal Advisory Committee Act (Public Law 92-463, October 6, 1972).

b. Executive Order 11769, dated February 21, 1974.

c. OMB Circular No. A-63, Revised March 27, 1974, and Transmittal Memoranda No. 1 (dated July 19, 1974), No. 4 (dated February 5, 1976), and No. 5 (dated March 7, 1977).

d. NMI 1150.2.

3. DEFINITIONS

a. The definitions set forth in NMI 1150.2 apply for the purposes of this Instruction.

b. Unless the context indicates otherwise, the term "committee" as used in this Charter applies also to subcommittees or other subgroups of the NASA Advisory Council or its related standing committees.

c. The term "program director" as used in this Charter refers to the Program Associate Administrators and, in the case of related staff office functions, to the official in charge of the relevant function (e.g., the Director, History Office).

4. ESTABLISHMENT

a. The NASA Advisory Council (hereafter referred to as the "Council") and its related standing committees in the substantive areas of aeronautics, history, life sciences, space and terrestrial applications, space sciences, and space systems and technology, are hereby established to provide a comprehensive aeronautics and space program advisory structure.

b. Pursuant to Section 9(a)(2) and Section 14(b) of the Federal Advisory Committee Act, the Administrator has determined that the existence of the Council and its related standing committees is in the public interest in connection with the performance of duties imposed upon NASA by law.

5. FUNCTIONS

a. The function of the Council is to consult with and advise the NASA Administrator or designee with respect to plans for, work in progress on, and accomplishments of NASA's aeronautics and space programs. In this capacity, and within the general confines of agendas submitted for its consideration, the Council will review and advise on (1) agency and program objectives, policies, and strategies; (2) the degree to which programs achieve their objectives and contribute to overall agency objectives; and (3) the means for the effective coordination of NASA's interests and activities with academic, scientific and engineering communities and institutions, and with the potential users of NASA's aerospace technologies such as commerce, industry, and state and local government agencies.

b. Within the parameters and restrictions placed on the Council above, the function of each of the standing committees is to consult with and advise the Council as a whole and NASA, through the NASA Chief Scientist, on that portion of the Council's overall functions which relates to its substantive area of responsibility, as defined in Attachment A hereto.

c. The function and expected duration of any subcommittee or other subgroup established pursuant to paragraph 9 hereof shall be as specified in the document creating it.

6. RELATIONSHIPS

a. The Council reports to the Administrator or designee and formally submits its positions, recommendations, and opinions to the Administrator. The Chief Scientist is NASA's principal point of contact in working relationships with the program directors.

b. The standing committees report to the Council and the Chief Scientist, and submit their positions, recommendations, and opinions to both of them. The respective program directors or their appropriate designees will serve as the primary working contacts between such committees and the NASA organization, and will be responsible for preparing responses to the recommendations of the committee.

c. The Executive Secretary of each committee will assure that appropriate and timely information flows to the program directors with respect to the recommendations, positions, and findings of the committee which are submitted to the Council or to the Chief Scientist.

d. The Council and all committees shall request such assistance as may be required from individuals or groups within or outside of NASA through the Chief Scientist.

e. Determination of NASA actions on recommendations of the Council and committees will be made by the Administrator or designee. The continuing status of actions by NASA in consequence of the recommendations of the Council or any committee shall be reported to the Council or committee by the cognizant Executive Secretary.

f. The Executive Secretary of the Council will provide support to the Administrator or designee and to the Chief Scientist in effecting these relationships.

7. MEMBERSHIP

*a. The membership of the Council will be listed as an attachment to this Charter.

b. The selection of a person to serve as a member of the Council, a standing committee, or a formal subgroup, will be based upon the individual's demonstrated interest in and ability to contribute significant advice on NASA's aeronautics and space programs. Appointments will be made for terms of one year, except that members of formal subgroups will be appointed for the expected duration of the subgroup. In order to infuse new people and ideas without losing continuity, some membership changes will be made each year, and members normally will not be appointed more than three years in succession. Not over one-fourth of the members of any committee may be NASA employees.

c. Approval of the NASA Administrator or designee is required for selection of the chairperson and members of the Council and the chairpersons of each committee. Committee members may be selected by the program director serving as principal working contact between that committee and the NASA organization. Other program directors associated with a committee should propose candidates for membership to the principal working contact.

d. The Council, each committee, and each subordinate subgroup shall have its own Executive Secretary who shall be a full-time salaried NASA employee.

*Changed by this revision.

e. The respective Chairpersons and Executive Secretaries of the Council, each committee, and each subordinate subgroup shall have the responsibilities specified in paragraph 12 of NMI 1150.2.

8. MEETINGS

Meetings of the Council and each of its related standing committees will be held periodically; ordinarily about two or three times a year. In addition, meetings of subgroups will be held as required. All such meetings shall be governed by the rules therefor set forth in paragraph 13 of NMI 1150.2. In addition to their attendance at and participation in open Council and committee meetings, interested persons will be permitted to file statements with the Council or a committee.

9. SUBCOMMITTEES OR OTHER SUBGROUPS

a. Subject to the approval of the Chief Scientist, the Chairperson of the Council is authorized to establish informal subcommittees or other subgroups to operate within the area of the Council's overall functions. An informal subgroup is one whose members are also members of the Council or one of its standing committees, and is generally temporary in nature. Meetings of informal subgroups shall be open to members of the public unless otherwise determined and announced in accordance with NMI 1150.2. Informal subgroups will not be used to circumvent the provisions of the Federal Advisory Committee Act.

b. Subject to the approval of the Chief Scientist and the Chairperson of the Council, the Chairperson of each standing committee is authorized to establish informal subcommittees or other subgroups to operate within the respective areas of disciplinary and programmatic interests specified in Attachment A. The definition of informal subgroups and conditions for their operation are as in subparagraph a.

c. Formal subcommittees or other subgroups of the Council or its standing committees will be established under a separate Charter attached to this Charter. A formal subgroup is one whose membership may include persons who are not members of the Council or one of its standing committees, or which is established to be of more than temporary duration.

10. COUNCIL AND COMMITTEE RECORDS

a. All records and files of the Council and each committee shall be maintained by the cognizant Executive Secretary. Such records shall include agendas, transcripts or minutes of meetings, working papers, drafts, studies, reports,

and any other documents or appendices thereto which were made available to or prepared by or for the Council or Committee.

b. Subject to the provisions of 5 USC 552, (the Freedom of Information Act) Council and committee records shall be available for public inspection and copying, at a single location designated by the cognizant Executive Secretary, until the Council or standing committee ceases to exist. Requests by members of the public for access to or release of such records will be handled in accordance with the provisions of NMI 1382.2.

c. The cognizant Executive Secretary will file at least eight copies of each report made by the Council or a committee with the Library of Congress. Copies of other Council or committee records will also be filed with the Library, to the extent required by regulations of the Office of Management and Budget.

11. ESTIMATED OPERATING COSTS

*The estimated annual operating cost of the Council and committees (including cost of staff support) is approximately $300,000 per year. The estimated staff years required for Council and committee activities (including staff support) is six staff years.

12. SUPPORTING SERVICES

Necessary staff and support services for the Council and subgroups thereof will be provided at the request of the Chief Scientist by appropriate Headquarters offices. Necessary staff and support services for each standing committee and subgroup thereof will be provided by the Headquarters office serving as principal working contact with that committee.

13. AVOIDANCE OF CONFLICTS OF INTEREST

a. Nongovernmental members of the Council and committees will be retained as government experts or consultants, and therefore will be expected to observe NASA regulations (NHB 1900.2) pertaining to the avoidance of conflicts of interest and the observance of ethical standards of conduct. A copy of such regulations and related instructions will be furnished to each nongovernmental member at the time of the appointment as a NASA expert or consultant.

b. Prior to participating in any meeting, nongovernmental members of the Council and committees must have prepared and submitted to NASA a "NASA Special Governmental

*Changed by this revision.

Employees Confidential Statement of Employment and Financial Interests" (NASA Form 1271).

14. DURATION

*The Council and its related standing committees will continue in existence until September 30, 1981, unless sooner terminated, or unless extended pursuant to the provisions of the Federal Advisory Committee Act.

15. FILING OF CHARTER

One copy of this Charter shall be filed with the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science and Technology within five working days of the date the Charter is approved. A copy of this Charter will also be furnished to the Library of Congress.

16. CANCELLATION

NMI 1156.34, dated December 12, 1977.

Russell Ritchie 1 OCT 1979
Deputy Associate Administrator
for External Relations

ATTACHMENTS

A. Substantive Areas of Responsibilities for Standing Committees.

B. Subcommittee on Aviation Safety Reporting System, Aeronautics Advisory Committee.

C. NASA Advisory Council Membership.

*Changed by this revision.

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ATTACHMENT A
NMI 1156.34A

October 1, 1979

NASA ADVISORY COUNCIL

SUBSTANTIVE AREAS OF RESPONSIBILITIES
FOR STANDING COMMITTEES

1. Aeronautics Advisory Committee

Concerned with basic aeronautics research and with aeronautics research and technology applicable to commercial air transportation (including all transport types, such as conventional, short, and vertical take-off and landing; and supersonic transports), general aviation, helicopters, and military aircraft. Technical disciplines relevant to the listed aviation categories include, but are not limited to, aerodynamics, aeronautical propulsion, avionics, structures and materials, and such special factors as aviation safety, aircraft operating systems, and man-vehicle technology.

(Principal Program Office Contact and Staff Support - Office of Aeronautics and Space Technology)

(Associate Program Office Contact - Office of Space Science (Life Sciences))

2. Historical Advisory Committee

Concerned with the NASA History Program, including review of historical archives, official NASA histories and historical reports, historical service to NASA and Government, and the program's relation to academic and public activities. The committee is also concerned with reviewing the relationship of NASA Headquarters Offices, field installations, and contractors to the NASA History Program, and to reviewing general objectives and procedures for ensuring effective relationships between NASA and academic and other institutions concerned with the history of space exploration and its impacts, and with the history of aeronautics and its impacts.

(Principal Office Contact and Staff Support - History Office)

3. Life Sciences Advisory Committee

Concerned with (1) the study and support of life in space utilizing the multiple disciplines of medical sciences, biological sciences, biotechnology, planetary biology and quarantine, manned missions, operational support, and life sciences payloads; (2) application of space technology to life sciences problems on earth, with emphasis on medicine, ecology, and animal tracking; (3) occupational and environmental medicine through health maintenance and awareness programs, medical data handling systems, and the provisions of medical test-bed for advanced bioinstrumentation; and (4) technology utilization for life sciences.

(Principal Program Office Contact and Staff Support - Office of Space Science)

(Associate Program and Staff Office Contacts - Office of Aeronautics and Space Technology, Office of Space and Terrestrial Applications, Office of Space Transportation Systems, Occupational Medicine Branch)

4. Space and Terrestrial Applications Advisory Committee

*Concerned with the application of space-related capabilities to (1) agriculture; (2) forestry; (3) hydrology; (4) atmospheric sciences; (5) ocean sciences, including oceanography and ocean dynamics; (6) geosciences, including geology, mineral exploration, earth dynamics, and land capability; (7) communications applications, including data management systems; and (8) materials processing in space.

(Principal Program Office Contact and Staff Support - Office of Space and Terrestrial Applications)

(Associate Program Office Contacts - Office of Space Science, Office of Aeronautics and Space Technology)

5. Space Science Advisory Committee

Concerned with the observation and study of: (1) major and minor bodies of the solar system and their interactions with the interplanetary environment; (2) basic matter and energy in the space environment; (3) cosmology and relativity physics; (4) stars, nebulae, galaxies, and interstellar and interplanetary space, and intergalactic matter; (5) the physical properties and nuclear and electromagnetic processes of the sun and the solar-planet relationships; and (6) the origin and characteristics of energetic particle radiation, including radiation belts, interplanetary plasma, solar and galactic cosmic rays, and auroral particles.

(Principal Program Office Contact and Staff Support - Office of Space Science)

(Associate Program Office Contacts - Office of Space and Terrestrial Applications, Office of Aeronautics and Space Technology)

6. Space Systems and Technology Advisory Committee

Concerned with research and technology applicable to space systems, including information systems (e.g., sensing and sensor support, communications, data processing), spacecraft systems (e.g., guidance and control, thermal control, materials and structures), space power systems, and space transportation systems (launch and orbital transfer propulsion).

*Changed by this revision.

* The committee is concerned also with technology discipline activities in electronics, space power and propulsion, and materials and structures, and includes consideration of the technologies required for terrestrial energy applications.

(Principal Program Office Contact and Staff Support - Office of Aeronautics and Space Technology)

(Associate Program Office Contacts - Office of Space and Terrestrial Applications, Office of Space Science, Office of Space Transportation Systems)

*Changed by this revision.

ATTACHMENT B
NMI 1156.34A

October 1, 1979

SUBCOMMITTEE ON AVIATION SAFETY REPORTING SYSTEM,
AERONAUTICS ADVISORY COMMITTEE

1. Functions

The functions of this Subcommittee are to:

a. Review and evaluate the NASA Aviation Safety Reporting System (ASRS) design and implementation plan in terms of its responsiveness to current and future aviation safety needs.

b. Provide advice and recommendations on the overall objectives, approach, content and structure of the ASRS relative to aviation safety needs.

c. Review and evaluate critical elements in the ASRS initial implementation plan including reporting forms, software system development and on-line operation, and the procedures for transfer of information to users.

d. Review and evaluate periodically progress of the operational system, recommending modifications to the ASRS as necessary.

e. Maintain review of all operations of the ASRS and provide advice with respect to the maintenance of the anonymity of persons submitting safety reports or persons named therein.

f. Report its recommendations to the NASA Advisory Council through the Aeronautics Advisory Committee regarding NASA's total effort related to aviation safety reporting.

*2. Membership

Mr. John H. Winant, Chair
Dr. Charles E. Billings, Executive Secretary

*3. Duration

This Subcommittee will continue in existence until Sept. 30, 1981, unless sooner terminated, or unless extended pursuant to the provisions of the Federal Advisory Committee Act.

*4. Estimated Operating Costs Through September 30, 1981

Four meetings, $52,000, including staff support (3/4 staff year).

*Changed by this revision.

ATTACHMENT C
NMI 1156.34A

October 1, 1979

NASA ADVISORY COUNCIL
MEMBERSHIP

Dr. William A. Nierenberg, Chair
Mr. Nathaniel B. Cohen, Executive Secretary

Committee Chairs:

Dr. Robert G. Loewy, NAC Aeronautics Advisory Committee
Dr. Thomas Hughes, NAC Historical Advisory Committee
Dr. Richard J. Wurtman, NAC Life Sciences Advisory Committee
Dr. John W. Firor, NAC Space and Terrestrial Applications Advisory Committee
Dr. Donald M. Hunten, NAC Space Science Advisory Committee
Mr. Robert L. Johnson, NAC Space Systems and Technology Advisory Committee

At-Large Members

Dr. Randolph W. Bromery
Dr. Alastair G.W. Cameron
Dr. Kingsley Davis
Dr. George B. Field
Mr. Daniel J. Fink
Mr. Willis M. Hawkins
Mr. James A. Michener
Dr. John E. Naugle
Dr. Roger G. Noll
Dr. William P. Slichter
Dr. Clifford V. Smith, Jr.
Dr. Winona B. Vernberg
Mr. Holden W. Withington

93-418 O—82——89

National Aeronautics and
Space Administration

Washington, D.C.
20546

AUG 2 1 1981

G (81-32074)

Honorable Don Fuqua
Chairman, Committee on
Science and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Fuqua:

This responds to your Committee's request contained in House Report 97-32 at page 24 which stated:

"INDEMNIFICATION OF CONTRACTORS BY NASA AGAINST THIRD PARTY LIABILITY

The Committee believes that NASA should provide third-party liability indemnifications to space systems contractors whenever feasible and in the best interest of the United States Government. The Committee recognizes NASA's close involvement in the total procurement process including NASA's spacecraft performance specifications, design, manufacture and reliability assessment. The Committee would envision that when it is in the best interest of the United States Government NASA would specify a required amount of contractor-obtained liability insurance coverage with additional indemnification to be provided by NASA. The Committee requests that NASA assign responsibilities to the General Counsel to coordinate an indemnification policy with the cognizant Executive Agencies and report its findings to the Committee no later than September 1, 1981. Section 308 of the National Aeronautics and Space Administration Act of 1958 as amended by Public Law 96-48 should be used as a guideline in developing Executive Order changes wherever practicable."

At this time, I shall provide an interim report as to the steps I have taken to determine, as requested by the Committee, to what extent it would be feasible and in the best interest of the United States Government to provide third-party liability indemnification to space systems contractors. In essence, the

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COMMITTEE ON SCIENCE
AND TECHNOLOGY

Office of Federal Procurement Policy (OFPP) with NASA support, has established an interagency task force to review this question and I expect that the task force will draft legislation or amendments to existing executive orders or regulations to implement their proposed recommendations to OFPP. The interagency task force is currently actively engaged in developing their position. I expect the product to be in the form of a recommendation to OFPP.

What follows is a more detailed accounting of the actions I have taken to respond to your Committee's request.

On receipt of your request, I sent a letter on June 12, 1981, to the Administrator for Federal Procurement Policy (Enclosure 1) requesting OFPP's assistance in developing an Executive Agency position on indemnification of U.S. Government contractors. This seemed reasonable since OFPP was then initiating a review of the same subject in order to respond to the Commission on Government Procurement Recommendation's H-4 and H-5 (Enclosure 2). The Administrator of OFPP, Donald E. Sowle, supported the idea of an interagency task force on indemnification and that task force first met on June 19, 1981. The membership of the interagency task force is enclosed (Enclosure 3).

I personally met with Don Sowle and representatives of the task force on two occasions to discuss the indemnification issues involved. The interagency task force has met five times and accomplished the following.

Firstly, it has compiled and reviewed relevant materials dealing with indemnification, including existing legislation, judicial decisions, Comptroller General decisions and prior work done by a OFPP task group in 1976 - 1977 which was established to implement the Commission on Government Procurement's Recommendations H-4 and H-5 (Enclosure 2).

Secondly, the task force invited to one of its sessions, for a discussion of their views on indemnification, Mr. Lawrence Stich of IBM Corporation and Mr. Victor Schwartz an attorney who was one of the major contributors to the study entitled Interagency Task Force on Product Liability (Jan. 1977) which was undertaken under direction of the U.S. Department of Commerce.

Thirdly, the task force, by letter of August 10, 1981, (Enclosure 4) requested information from certain executive agencies, which information would be helpful in determining the justification for and scope of indemnification of Government contractors. The agencies are required to respond by September 1, 1981.

Fourthly, the task force is exploring the possibility of amending Executive Order 10789, as amended, in order to authorize the indemnification of U.S. Government contractors. Part of this investigation will consist of requesting a legal opinion by the Department of Justice as to the propriety of expanding the scope of the Executive Order. That request for a legal opinion is now being prepared and we expect it to be issued this week.

Lastly, the task force has a study underway as to the extent the current law administered by the Federal Emergency Management Agency, which authorizes disaster relief, will solve, in a practical sense, the problem of assuring prompt and adequate compensation for victims of catastrophic accidents ocurring in connection with Government programs.

In summary, the Office of Federal Procurement Policy has currently underway a vigorous investigation by its interagency task force on indemnification of the justification for and scope of indemnification of U.S. Government contractors. The study is not limited to NASA contractors who are exposed to third party liability in the space effort but is Government wide. This task force will present its recommendation to OFPP, and after appropriate review and approval within the Administration, the Administration will be in a position to decide what, if any changes to the law or Executive Order 10789, as amended are necessary and appropriate. I anticipate that this will be done expeditiously and I will keep you informed of the progress of the investigation.

Sincerely,

S. Neil Hosenball

S. Neil Hosenball
General Counsel

Enclosures

cc:
Donald E. Sowle

National Aeronautics and
Space Administration

Washington, D.C.
20546

81-794
OFPP
Coleman
Copy to Sowle

G (81-32051)

JUN 12 1981

Mr. Donald E. Sowle
Administrator for Federal
Procurement Policy (Designate)
New Executive Office Building
726 Jackson Place, NW
Washington, DC 20503

Dear Mr. Sowle:

The House Committee on Science and Technology in H.R. 97-32, page 24 (copy enclosed), requested that I, in my capacity as General Counsel of NASA, coordinate an indemnification policy with cognizant Executive Agencies and report back the Executive Agencies' findings to the Committee no later than September 1, 1981. The Committee believed that NASA should provide third party liability indemnification to NASA space systems contractors whenever feasible and in the best interest of the United States. The Committee suggested that section 308 of the National Aeronautics and Space Act of 1958, as amended by Pub. L. 96-48 (42 U.S.C. 2458b), be used as a guide (copy enclosed) "in developing Executive Order changes wherever practicable." I believe this reference to Executive Order changes is a reference to Executive Order 10789, as amended, which was issued under Pub. L. 85-804 and authorizes U.S. Government agencies to indemnify its contractors under certain limited circumstances. Thus, the Committee envisages the development of an indemnification policy which affects other agencies of the U.S. Government as well as NASA.

I request your assistance in developing an Executive Agency position on indemnification of U.S. Government contractors. I suggest that an intra-agency task group, including a Department of Justice and NASA representative, be established by OFPP for that purpose. The attempt to develop such a position would probably dovetail with OFPP's review of the current Executive Agency position on indemnification of U.S. Government contractors.

If, as a result of the inter-agency review, there is a recommended change in the indemnification of U.S. Government contractors, this would require at a minimum revision of Executive Order 10789, as amended, or the enactment of additional legislation.

Please let me know what assistance NASA can lend to the development of an Executive Agency position on indemnification of U.S. Government contractors. My phone number is 755-3875. I appreciate your assistance.

Sincerely,

S. Neil Hosenball

S. Neil Hosenball
General Counsel

Enclosures

97TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
1st Session } { No. 97-32

AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR FISCAL YEAR 1982

MAY 8, 1981.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

---

Mr. FUQUA, from the Committee on Science and Technology, submitted the following

REPORT

together with

MINORITY VIEWS

[To accompany H.R. 1257]

[Including cost estimate and comparison of the Congressional Budget Office]

The Committee on Science and Technology, to whom was referred the bill (H.R. 1257) to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes, having considered the same, report favorably thereon with amendments (shown in italic in the bill accompanied by this report) and recommend that the bill, as amended, do pass.

The amendments are as follows:

Page 2, line 1, strike out "$2,230,000,000" and insert "$2,134,000,000".
Page 2, line 2, strike out "$1,043,000,000" and insert "$903,900,000".
Page 2, line 4, strike out "$451,400,000" and insert "$350,400,000".
Page 2, line 5, strike out "$256,100,000" and insert "$215,200,000".
Page 2, line 7, strike out "$472,900,000" and insert "$410,900,000".
Page 2, line 8, strike out "$14,600,000" and insert "$12,600,000".
Page 2, line 10, strike out "$322,600,000" and insert "$276,000,000".
Page 2, line 12, strike out "$141,000,000" and insert "$129,300,000".
Page 2, line 13, strike out "$4,400,000" and insert "$2,000,000".
Page 2, line 14, strike out "$435,200,000" and insert "$400,200,000".
Page 2, strike out lines 19 and 20.
Page 2, line 21, strike out "(3)" and insert "(2)".
Page 2, line 23, strike out "(4)" and insert "(3)".

budget underwent major revisions in a matter of weeks just before our authorization process had to begin. For example, there was no time for consultation with the space science community on the impacts of the budget revision. The guaranteed availability of a continuing advisory committee apparatus with cognizance of all NASA programs would provide the Congress with a very useful source of advice having a broad perspective and current information. To summarize, the Committee feels the Agency has not always been forthcoming with information and seeks this way of ensuring that at least another potential source is always available.

The Committee request is not intended to interfere with the organization of existing advisory committees. The request would impact their operations only in the following ways: (1) They would be able to set their own agendas and terms of discussion (at least in part) rather than having this done totally by NASA; (2) They would respond to questions and issues raised by this Committee; (3) They would make an annual report to the Congress.

The Administrator should continue to appoint as members of the advisory committees highly qualified individuals whose advice and counsel will be useful to him and to the Congress. Insofar as possible the Committees should be broadly representative of the space community and should be from diverse geographic areas.

The Committee recognizes the existence of other independent advisory groups such as the Space Science Board of the National Academy of Sciences. Clearly, this new request would in no way supplant them or reflect adversely on them. Such groups advise other government agencies as well as NASA, and are responsible to their parent organizations. Thus, they provide counsel from a different vantage point. Their advice has been useful to this Committee in the past and we look forward to their continued wise assistance.

INDEMNIFICATION OF CONTRACTORS BY NASA AGAINST THIRD PARTY LIABILITY

The Committee believes that NASA should provide third-party liability indemnifications to space systems contractors whenever feasible and in the best interest of the United States Government. The Committee recognizes NASA's close involvement in the total procurement process including NASA's spacecraft performance specifications, design, manufacture and reliability assessment. The Committee would envision that when it is in the best interest of the United States Government NASA would specify a required amount of contractor-obtained liability insurance coverage with additional indemnification to be provided by NASA. The Committee requests that NASA assign responsibilities to the General Counsel to coordinate an indemnification policy with the cognizant Executive Agencies and report its findings to the Committee no later than September 1, 1981. Section 308 of the National Aeronautics and Space Administration Act of 1958 as amended by Public Law 96-48 should be used as a guideline in developing Executive Order changes wherever practicable.

unless (A) a period of 30 days has passed after the Administrator or his designee has transmitted to the Speaker of the House of Representatives and to the President of the Senate and to the Committee on Science and Technology of the House of Representatives and to the Committee on Commerce, Science, and Transportation of the Senate a written report containing a full and complete statement concerning (1) the nature of such construction, expansion, or modification, (2) the cost thereof including the cost of any real estate action pertaining thereto, and (3) the reason why such construction, expansion, or modification is necessary in the national interest, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 4. Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Technology or the Senate Committee on Commerce, Science, and Transportation,

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by subsections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee,

unless (A) a period of 30 days has passed after the receipt by the Speaker of the House of Representatives and the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

Federal research funds, geographical distribution
42 USC 2459 note.

SEC. 5. It is the sense of the Congress that it is in the national interest that consideration to be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

SEC. 6. (a) Paragraph 13 of subsection (c) of section 203 of the National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2473(c)(13)), is amended by striking out "$5,000" where it appears and inserting in lieu thereof "$25,000".

42 USC 2459.

(b) The National Aeronautics and Space Act of 1958, as amended, is amended (1) by redesignating section 308 as section 309 thereof; and (2) by inserting the following new section:

"INSURANCE AND INDEMNIFICATION

Liability insurance
42 USC 2456b.

"SEC. 308. (a) The Administration is authorized on such terms and to the extent it may deem appropriate to provide liability insurance for any user of a space vehicle to compensate all or a portion of claims by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle. Appropriations available to the Administration may be used to acquire such insurance, but such appropriations shall be reimbursed to the maximum

Public Law 96-48
96th Congress

An Act

To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes.

Aug. 8, 1979
[H.R. 1786]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration to become available October 1, 1979.

National Aeronautics and Space Administration Authorization Act, 1980.

(a) For "Research and development," for the following programs:

(1) Space Shuttle, $1,586,000,000;
(2) Space flight operations, $463,300,000;
(3) Expendable launch vehicles, $70,700,000;
(4) Physics and astronomy, $337,500,000;
(5) Planetary exploration, $220,200,000;
(6) Life sciences, $45,900,000;
(7) Space applications, $336,300,000;
(8) Technology utilization, $12,100,000;
(9) Aeronautical research and technology, $309,300,000;
(10) Space research and technology, $119,400,000;
(11) Energy technology, $5,000,000; and
(12) Tracking and data acquisition, $332,800,000.

(b) For "Construction of facilities," including land acquisition, as follows:

(1) Modification of static test facility, Ames Research Center, $2,900,000;
(2) Construction of large aircraft maintenance dock, Hugh L. Dryden Flight Research Center, $1,500,000;
(3) Rehabilitation and modification of flight operations facilities, Ellington Air Force Base, $1,760,000;
(4) Modifications to central instrumentation facility, John F. Kennedy Space Center, $1,260,000;
(5) Modifications to operations and checkout building, John F. Kennedy Space Center, $950,000;
(6) Rehabilitation of roof, launch control center, John F. Kennedy Space Center, $600,000;
(7) Modifications of model support system 8-foot high temperature structures tunnel, Langley Research Center, $1,410,000;
(8) Modifications to 8-foot transonic pressure tunnel, Langley Research Center, $2,000,000;
(9) Modification of transonic dynamics tunnel, Langley Research Center, $970,000;
(10) Rehabilitation and modification of gas dynamics laboratory, Langley Research Center, $3,600,000;
(11) Modifications to central air system, various buildings, Lewis Research Center, $5,720,000;
(12) Modifications to various buildings, Marshall Space Flight Center, $2,640,000;
(13) Rehabilitation of roofs, various buildings, Marshall Space Flight Center, $900,000;

extent practicable by the users under reimbursement policies established pursuant to section 203(c) of this Act.

"(b) Under such regulations in conformity with this section as the Administrator shall prescribe taking into account the availability, cost and terms of liability insurance, any agreement between the Administration and a user of a space vehicle may provide that the United States will indemnify the user against claims (including reasonable expenses of litigation or settlement) by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle, but only to the extent that such claims are not compensated by liability insurance of the user: *Provided*, That such indemnification may be limited to claims resulting from other than the actual negligence or willful misconduct of the user.

Ante, p. 348

"(c) An agreement made under subsection (b) that provides indemnification must also provide for—

"(1) notice to the United States of any claim or suit against the user for the death, bodily injury, or loss of or damage to the property; and

"(2) control of or assistance in the defense by the United States, at its election, of that suit or claim.

"(d) No payment may be made under subsection (b) unless the Administrator or his designee certifies that the amount is just and reasonable.

"(e) Upon the approval by the Administrator, payments under subsection (b) may be made, at the Administrator's election, either from funds available for research and development not otherwise obligated or from funds appropriated for such payments.

"(f) As used in this section—

Definitions

"(1) the term 'space vehicle' means an object intended for launch, launched or assembled in outer space, including the Space Shuttle and other components of a space transportation system, together with related equipment, devices, components and parts;

"(2) the term 'user' includes anyone who enters into an agreement with the Administration for use of all or a portion of a space vehicle, who owns or provides property to be flown on a space vehicle, or who employs a person to be flown on a space vehicle; and

"(8) the term 'third party' means any person who may institute a claim against a user for death, bodily injury or loss of or damage to property.".

Effective date. 42 USC 2458b note.

(c) This section shall be effective October 1, 1979.

Short title.

SEC. 7. This Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1980".

Approved August 8, 1979.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 96-52 (Comm. on Science and Technology) and No. 96-371 (Comm. of Conference).

SENATE REPORTS: No. 96-207 (Comm. on Commerce, Science, and Transportation) and No. 96-252 (Comm. of Conference).

CONGRESSIONAL RECORD, Vol. 125 (1979):

Mar. 28, considered and passed House.

June 14, considered and passed Senate, amended.

July 23, Senate agreed to conference report.

July 27, House agreed to conference report.

REPORT OF THE COMMISSION ON GOVERNMENT PROCUREMENT
(December 31, 1972)

Recommendation H-4: "Enact legislation to assure prompt and adequate compensation for victims of catastrophic accidents occurring in connection with Government programs."

Recommendation H-5: "Enact legislation to provide Government indemnification, above the limit of available insurance, of contractors for liability damage arising from a catastrophic accident occurring in connection with a Government program."

Enclosure 2

INDEMNIFICATION INTERAGENCY TASK FORCE MEMBERSHIP LIST

Richard Cambosos — 275-5544
Office of the General Counsel
General Accounting Office
444 G Street, NW, Room 7072
Washington, DC 20548

Edgar Merson — 252-6902
Office of General Counsel
Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Jess Lasken — 357-9442
Office of General Counsel
National Science Foundation
Washington, DC 20550

Edmund Traccarella — 695-2041
Office of General Counsel
Strategic Systems Project Office
Crystal Mall No. 3, Room 1146
Washington, DC 20376

Robert J. Wojtal — 755-3169
Office of General Counsel
NASA Headquarters
Code GK-3
Washington, DC 20546

Jeffrey Axelrad — 724-6810
Director, Torts Branch
Civil Division
Department of Justice
Washington, DC 20530

Hudson Reagan — 492-8668
Office of Executive Legal Director
Nuclear Regulatory Commission
Washington, DC 20555

William Coleman — 395-3501
Office of Federal Procurement Policy
Room 9013, New Executive Office Building
726 Jackson Place, NW
Washington, DC 20503

Ted Barrett — 377-2101
Policy Staff
Department of Commerce
Room 1898C
Washington, DC 20230

Tom Aenora — 653-7270
Office of General Counsel
Federal Emergency Management Agency
Washington, DC 20472

Enclosure 3

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

OFFICE OF FEDERAL PROCUREMENT POLICY

AUG 10 1981

MEMORANDUM FOR: Office of Federal Procurement Policy Agency Contact Points

FROM: Interagency Task Group on Indemnification
Office of Federal Procurement Policy

SUBJECT: Indemnification of Government Contractors

We need your help in determining whether this task group should support a proposal to indemnify Government contractors for liability arising out of Government programs.

More than four years ago, on March 9, 1977, the Office of Federal Procurement Policy requested of selected agencies their comment on a report of a task group which recommended legislation to deal with the Commission on Government Procurement (COGP) Recommendation H-5. This COGP recommendation stated:

> "H.5. Enact legislation to provide Government indemnification, above the limit of available insurance, of contractors for liability damage arising from a catastrophic accident occurring in connection with a Government program."

Agency comments on this recommended legislation were studied by OFPP, but OFPP at that time, for various reasons, did not seek the introduction of legislation in Congress.

Today there is a renewed interest in determining whether COGP recommendation H-5 should be implemented. For example, House Report 97-32, page 24, recommended that:

> "NASA should provide third-party liability indemnifications to space systems contractors whenever feasible and in the best interest of the United States Government.... The Committee requests that NASA ... coordinate an indemnification policy with the cognizant Executive Agencies and report the findings to the Committee no later than September 1, 1981."

Now we have a new opportunity to deal with the COGP recommendation H-5 and ask that you respond to the following questions [redacted]. Your response will be used by the task group in determining whether we should support COGP recommendation H-5.

Enclosure 4

1. Identify those instances, since January 1, 1969, when a potential bidder on a Government contract refused to bid or dropped out of negotiations because of the risk of liability arising out of contract performance.

2. Describe those instances since January 1, 1969, when your agency was compelled to agree to indemnify a contractor from third party liability in order to procure needed materials or services. Identify separately those instances when your agency relied on statutory authority (including Public Law 85-804, as implemented by Executive Order 10789, as amended) which specifically authorize indemnification from those instances, as illustrated in the enclosed Comptroller General Decision, B-194983 of September 3, 1980, when your agency did not rely on such specific statutory authority to indemnify but relied upon a rule of necessity.

3. Describe those instances since January 1, 1969, when your agency agreed to indemnify a contractor for liability not in excess of available appropriations for the purpose of saving Government money.

Please forward responses to the Indemnification Task Group, Office of Federal Procurement Policy, Room 9013, New Executive Office Building, 726 Jackson Place, N. W., Washington, D. C. 20503.

William S. Coleman, Jr.

Robert J. Wojtal
Co-Chairmen

Enclosure

DECISION

THE COMPTROLLER GENERAL
OF THE UNITED STATES
WASHINGTON, D.C. 20548

FILE: B-194983 DATE: September 3, 1980

MATTER OF: Government indemnification of public utilities against loss arising out of sale of power to Government.

DIGEST: General Services Administration (GSA) may procure power under tariff or contract requiring customer to indemnify utility against liability arising from delivery of power. GSA has authority to procure power for Government under tariffs. Where no other practical source exists, tariff requirement is applied uniformly to purchases, without singling out Government, and risk of loss is remote, GAO will interpose no objection to existing practice of agreeing to tariff, with indemnity requirement, nor to proposed contract with similar indemnity provision. However, GSA should report situation to Congress.

This decision concerns the propriety of agreement by the General Services Administration (GSA) to certain indemnity provisions in procuring public utility services for Government agencies and establishments pursuant to section 201(a) of the Federal Property and Administrative Services Act of 1949, as amended.

GSA states in its request for our decision:

"Increasingly, the public utilities are attempting to insert an indemnity provision which, among other things, holds the Government liable to protect and save the utility companies harmless and indemnified from injury or damage to persons and property occasioned by the provision of the utility services.

"A typical indemnification provision reads as follows:

"'Customer assumes all responsibility for the electric power and energy delivered hereunder

after it leaves company's lines at the point of delivery, as well as for the wires, apparatus and appurtenances used in connection therewith where located at or beyond the point of delivery; and Customer hereby agrees to protect and save Company harmless and indemnified from injury or damage to persons and property occasioned by such power and energy or by such wires, apparatus and appurtenances located at and beyond said point of delivery, except where said injury or damage shall be shown to have been occasioned by the negligence of Company or its contractors. Further, Company shall not be responsible for injury or damage to anyone resulting from the acts of the employees of Customer or of Customer's contractors in tampering with or attempting to repair and/or maintain any of Company's lines, wires, apparatus or equipment located on Company's side of the point of delivery; and Customer will protect, save harmless and indemnify Company against all liability, loss, cost, damage and expense, by reason of such injury or damage to such employee or to any other person or persons, resulting from such acts of Customer's employees or contractor.'"

GSA also points out that:

"In many instances, the public utilities will not consent to any contract without an agreement by the Government to indemnify or protect the public utility from liability in case of injury or property damage.* * *

"The companies argue that they are required to include liability or indemnity provisions by the tariffs under which they provide utility services. They hold that they cannot legally provide the services without such protection."

With respect to the latter argument, the Supreme Court has ruled several times that such provisions in the rate schedule cannot preclude the Government from negotiating contracts for utility service which would omit the indemnification provision. (See Public Utilities Commission of California v. United States, 355 U.S. 534 (1958); Paul v. United States, 371 U.S. 245 (1963);

93-418 O—82——90

United States v. Georgia Public Service Commission, 371 U.S. 285 (1963).

GSA has been for sometime and is now procuring electricity under tariffs which include indemnity provisions of the kind now proposed to be included in contracts. The Acting Administrator is concerned that, since the proposed clause contains no limitation on the maximum liability of the Government, he is precluded by law from entering into contracts with these clauses. He is aware of our long line of decisions which hold that, unless otherwise authorized by law, an indemnity provision in a contract which subjects the United States to a contingent and undetermined amount of liability would violate 31 U.S.C. § 665(a) (the Anti-deficiency Act) and 41 U.S.C. § 11 (the Adequacy of Appropriations Act) since it can never be said that sufficient funds have been appropriated to cover such contingencies. See, for example, 7 Comp. Gen. 507 (1928); 16 id. 803 (1937); and 35 id. 85 (1955). See also California-Pacific Utilities Co., v. United States, 114 Ct. Cl. 703, 715-716 (1971).

In 54 Comp. Gen. 824 (1975), we proposed that a clause be inserted in any contract providing for assumption of risk for contractor-owned property which limits the amount of such risk to appropriations available for indemnity payments at the time a loss arises, with no implication that the Congress will be required to appropriate funds to make up for any deficiency. This solution would be unacceptable to the utilities, according to GSA, because there is no real assurance that they would be protected in the event of a large award for personal injury.

As a possible solution, GSA's letter suggests adding the following proviso to the proposed indemnification clause:

> "Provided, however, that nothing herein shall bind or obligate the Government for any liability beyond that for which it would be liable under the Federal Tort Claims Act."

The precise effect of this proviso is unclear. If the intent is to restrict the Government's liability to the liability it would incur even without the indemnification clause, i.e., liability under the Federal Tort Claims Act (FTCA) to the victim of the United States' negligence, then we find it unobjectionable. However, the proviso would not make funds available to indemnify the

B-194983

utility for payments which it might make to the victim, should the victim choose to seek recovery from the utility instead of from the United States.

The problem cannot be resolved without new legislation if we adopt an overly technical and literal reading of the Anti-deficiency Act in this situation. We do not think such a reading is appropriate under these circumstances. GSA is authorized to procure utility services for the Government and to do so under utilities tariffs. The procurement of goods or services from State-regulated utilities which are virtually monopolies is unique in important ways. As a practical matter, there is no other source for the needed goods or services. Moreover, the tariff requirements, such as this indemnification undertaking, are applicable generally to all of the same class of customers of the utility, and are included in the tariff only after administrative proceedings in which the Government has the opportunity to participate. The United States is not being singled out for discriminatory treatment nor, presumably, can it complain that the objectionable provision was imposed without notice and the opportunity for a hearing.

Under the circumstances, we have not objected in the past to the procurement of power by GSA under tariffs containing the indemnity clause and there is no reason to object to the purchase of power under contracts containing essentially the same indemnity clause. As noted already, this has of necessity been the practice in the past. The possibility of liability under the clause is in our judgment remote. In any event, we see little purpose to be served by a rule which prevents the United States from procuring a vital commodity under the same restrictions as other customers are subjected to under the tariff if the utility insists that the restrictions are non-negotiable. However, because the possibility exists, however remote, that these agreements could result in future liability in excess of available appropriations, GSA should inform the Congress of the situation.

Harry R. Van Cleve
For the Comptroller General
of the United States

National Aeronautics and
Space Administration

Washington, D.C.
20546

G(82-32055)

JUL 2 8 1982

Honorable Don Fuqua
Chairman, Committee on
Science and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Fuqua:

This is the second interim report as to the steps I have taken to determine, as requested by the Committee, to what extent it would be feasible and in the best interest of the United States Government to provide third-party liability indemnification to space systems contractors. This is to advise that NASA is in the process of forwarding a letter to the Office of Management and Budget recommending that Executive Order 10789 be amended to permit NASA to indemnify its space contractors for "space activities." We believe that other Executive Agencies will not object to this proposed amendment and it is also our understanding that the Office of Federal Procurement Policy supports this amendment to the Executive Order.

The delay in NASA obtaining authority to indemnify its space contractors was caused primarily by the Department of Justice's objection on policy grounds to an amendment of Executive Order 10789 as proposed by the OFPP Interagency Task Force on Indemnification. Subsequently, however, the Department of Justice stated that it would not object to a limited amendment of that Executive Order to permit the indemnification of contractors involved in space activity under appropriate circumstances.

What follows is a more detailed accounting of the actions I have taken to respond to your requests since my first interim report to your Committee on August 21, 1981.

On January 28, 1982, the OFPP Interagency Task Force on Indemnification issued its report (Enclosure 1). The Task Force concluded that there is a justification for amending Executive Order 10789, as amended, so that an increased number of Executive Agencies may agree to indemnify its contractors if the national defense would be facilitated thereby and if either

the contract work (i) is unusually hazardous or nuclear in nature or (ii) gives rise to the possibility of catastrophic losses. The representative of the Department of Justice on this Task Force dissented from the recommendation (Enclosure 1). On February 20, 1982, the Administrator of OFPP forwarded that report to the heads of the Executive Agencies and Establishments along with a proposed amendment to Executive Order 10789 (Enclosure 2). The memorandum requested that Government agencies review the attached report and draft Executive Order and provide the agencies' views.

On February 6, 1982, the NASA Administrator sent to the Deputy Director, Office of Management and Budget (Enclosure 3), and to the Attorney General of the United States (Enclosure 4) a letter requesting their support in amending Executive Order 10789 as recommended by the OFPP Interagency Task Force on Indemnification.

On February 26, 1982, the Assistant Attorney General, Civil Division, Department of Justice, provided the views of the Department of Justice with respect to the recommendations of the OFPP Interagency Task Force on Indemnification (Enclosure 5). The Department of Justice believed that the proposed modifications to Executive Order 10789 should not be made. The Assistant Attorney General agreed with the dissenting views of the Justice representative on the Task Force. On March 3, 1982, the NASA Administrator again appealed to the Attorney General of the United States (Enclosure 6) asking that he personally review and reconsider the position taken by the Department of Justice (Enclosure 5).

Because I was of the view that the objection of the Department of Justice would probably delay the amendment to the Executive Order, I sought, on behalf of NASA, to amend Executive Order 10789 to deal with NASA's limited problem; that is, an amendment which would permit NASA to indemnify its contractors who were involved in space activities. Accordingly, on March 9, 1982, I forwarded to Mr. Donald Sowle, Administrator of the Office of Federal Procurement Policy, a letter (Enclosure 7) asking his office to support such an amendment to Executive Order 10789. On March 9, 1982, I also forwarded this proposed amendment dealing with space activities to the Assistant Attorney General, Civil Division, Department of Justice, (Enclosure 8), asking that he review the proposed amendment, and provide his views with respect to this very

limited indemnity proposal. On June 11, 1982, the Assistant Attorney General informed me (Enclosure 9) that the Department of Justice would not object to the proposed amendment if NASA is of the view, and if the Office of Management verifies, that NASA would incur substantial risk that it would be unable to enter into contracts for essential space activities without the expanded authority to indemnify for space activities which NASA proposes (Enclosure 9).

I have prepared a proposed amendment to Executive Order 10789 which would permit NASA to indemnify its contractors and subcontractors who are involved in space activities. The amendment is currently being staffed through NASA. I expect that it will be forwarded to the Office of Management and Budget by August 1, 1982.

I believe that the amendment of the Executive Order which would authorize NASA to indemnify its contractors for space activities is necessary in order for NASA to fulfill its mission. There is indeed a substantial risk that NASA would not be able to obtain the necessary participation of private contractors in essential space activities without this additional authority. In addition, it has become obvious that it would be extremely expensive to NASA to continue as it has. This is evidenced by the enclosed letter of July 7, 1982, from Rockwell International's Director of Contract and Pricing to a NASA Contracting Officer at the Johnson Space Center. This letter (Enclosure 10) indicates that the premium cost of $2,950,000 will be passed on to NASA for Rockwell's insurance of three Shuttle launches from third-party liability. It is conceivable that NASA could incur premium costs for insurance of all of its contractors and subcontractors for each Shuttle launch of $5,000,000 per launch. The concern of the NASA contractors and subcontractors appears to be primarily with respect to product liability damage to users of the Shuttle as well as to the customers of such users. For these reasons, among others, we are now taking action to recommend that Executive Order 10789 be amended to permit NASA to indemnify its contractors for space activities.

I cannot say with certainty that NASA will be successful in obtaining our proposed amendment to Executive Order 10789 or if it can be accomplished prior to the flight of STS-5. I remain seriously concerned that the lack of such indemnification

authority will seriously impact our subcontractor and supplier structure as well as imposing additional unnecessary costs on Shuttle operations.

I will continue to keep you advised of the status. Please call me if I can be of further assistance to you or your Committee at 755-3875.

Sincerely,

S. Neil Hosenball
General Counsel

Enclosures

REPORT

OF THE

OFPP INTERAGENCY TASK FORCE ON INDEMNIFICATION

PART I

INDEMNIFICATION OF GOVERNMENT CONTRACTORS

AGAINST THIRD PARTY LIABILITY CLAIMS

January 28, 1982

Mr. Donald E. Sowle
Administrator for Federal
Procurement Policy
New Executive Office Building
726 Jackson Place, NW
Washington, DC 20503

Dear Mr. Sowle:

Forwarded herewith is Part I of a report by the OFPP Interagency Task Force on Indemnification. Part I deals solely with the indemnification of Government contractors. This Task Force was established in response to the Commission on Government Procurement's recommendations H-4 and H-5 and in response to a letter of June 12, 1981, from the General Counsel of NASA, which identified a request by the House Committee on Science and Technology recommending that NASA coordinate an indemnification policy with cognizant Executive Agencies.

With respect to the Procurement Commission's recommendation H-5, the Task Force concludes that there is a justification for amending E.O. 10789, as amended, so that an increased number of Executive Agencies may agree to indemnify its contractors if the national defense would be facilitated thereby and if either the contract work (i) is unusually hazardous or nuclear in nature or (ii) gives rise to the possibility of catastrophic losses. A recommended amendment to E.O. 10789 is included in Part I.

With respect to the Procurement Commission's recommendation H-4, the Task Force is continuing its research and discussions. We expect that the Task Force will conclude its work on H-4 and provide its recommendations in Part II of its report on or about March 1, 1982.

Sincerely,

William Coleman
William Coleman
Co-Chairman

Robert J. Wojtal
Robert J. Wojtal
Co-Chairman

Enclosure

OFPP Interagency Task Force on Indemnification
Approval of Part I of the Report

Part I of the report of the OFPP Interagency Task Force on Indemnification is hereby approved by the following members of the Task Force. This approval is based on the personal analysis of each member and does not necessarily represent the views of their agencies.

Co-Chairman:
William Coleman
Office of Federal Procurement Policy

Co-Chairman:
Robert J. Wojtal
National Aeronautics and Space Administration

Members:
Tom Asnora
Federal Energency Management Agency

Ted Barrett
Department of Commerce

Richard Canbosos
General Accounting Office

Jess Lasken
National Science Foundation

Edgar Henson
Department of Energy

Hudson Reagan
Nuclear Regulatory Commission

Edmund Traccarella
Department of the Navy

The following members of the Task Force on Indemnification have not approved Part I of the Task Force on Indemnification for the reasons explained in the Annex to this report.

Jeffrey Axelrad
Department of Justice

I. Introduction/Summary of Conclusions

Under the auspices of the Office of Federal Procurement Policy, an OFPP Interagency Task Force on Indemnification was established on June 19, 1981. The Task Force was established to develop an Executive Agency position on: (1) the indemnification of Government contractors against third party liability claims 1/ and (2) the compensation of catastrophic accident victims who were damaged by Government contractors. 2/ The General Accounting Office, on request, provided a representative to the Task Force to participate in the Task Force's work.

The resulting recommended position is contained in this Part I which focuses solely on the indemnification of Government contractors against third party liability claims.

A summary of the Task Forces conclusions follows:

1. There is a reasonable justification for amending E.O. 10789, as amended, to authorize all Executive Agencies who may exercise functions in connection with the national defense to agree to indemnify contractors against third party liability claims under the authority of Public Law 85-804 and subject to the other conditions in E.O. 10789, as amended.

2. E.O. 10789 also should be amended to permit an eligible agency to agree to indemnify a contractor if the particular contract gives rise to the possibility of "catastrophic losses" which should be defined as "losses which the particular contractor cannot reasonably protect against through private insurance or self-insurance by the payment of a reasonable premium or the establishment of or reliance on a reasonable self-insurance reserve."

3. The head of an Executive Agency has the authority to broadly construe the clause appearing in paragraph 1 of E.O. 10789, as amended, which authorizes the agency to agree to indemnify a contractor whenever in his judgment "the national defense will be facilitated thereby."

4. The Task Force is not now prepared to recommend that there is a convincing justification to provide through legislation for the indemnification of all Government contractors. Furthermore, the Task Force believes that if the Executive Order is amended as proposed, indemnification will be made available to most contractors who need the protection of indemnification. Some members of the Task Force believe that legislation should be drafted to reverse the precedent of

Stencel Aero Engineering Corp. v. United States, 431 U.S. 666 (1977) and, moreover, to require the Government to indemnify a contractor where the contractor is held liable under the doctrine of strict liability as a result of Government imposed specifications or drawings. However, a majority of the Task Force believed that a recommendation proposing such a sweeping change in its United States law should be supported by an in depth study but the Task Force did not have the facilities, staff, or time to accomplish such a study. Moreover, such a study would no doubt duplicate the work underlying H.R. 1504, 97th Cong., 1st Sess. a bill "To provide indemnity for suppliers of products to the Government in certain cases in which such suppliers become liable for loss with respect to those products, and for other purposes" and similar bills which the Congress has had under consideration recently. Finally, we believe such a study should be undertaken by a team representing the various interests affected and not solely representatives of Government agencies.

II. Justification for Revision of E.O. 10789, as amended.

A. Commission on Government Procurement Recommendation

The Task Force notes that the Commission on Government Procurement, in its 1972 report, found that the dramatic scientific and technological advances occurring in the past decades were frequently initiated and paid for by the Federal Government, particularly in "national defense, space, and nuclear programs" and that there was a possibility that a catastrophic accident could result from these programs.3/ The Commission concluded that existing laws were inadequate to shield contactors and subcontractors from uninsurable risks and to protect the victims of the accident.4/

Similarly, the Task Force believes that particularly in national defense programs there is the remote potential of catastrophic losses i.e., losses in excess of reasonably available insurance. Upon exhausting whatever insurance coverage that is available, such losses we believe could jeopardize a contractor's financial and productive capacity, and even the contractor's continuing existence, and potentially leave uncompensated victims of the accident who cannot recover against the defunct contractor. Innovative companies are apt to be particularly reluctant to face the risk of entering into a government contract or subcontract where the company gambles with the continuing existence of its business if a catastrophic accident should result.

B. House Committee on Science and Technology Recommendation

As previously indicated5/ the House Committee on Science and Technology's assessment and recommendation was that, if it

was determined to be in the best interest of the United States, it believed that particularly with respect to space system contractors those contractors should be indemnified in excess of a required amount of liability insurance. The Committee also suggested that an Executive Order should be amended to accomplish this whenever practicable; presumably the Committee was referring to E.O. 10789 as amended.

C. Federal Government Agencies Indicate Need

On August 10, 1981, the Task Force sent a memorandum to thirty-five Executive Agencies and in effect asked those agencies if in their experience there was a need to indemnify their contractors. This memorandum is enclosed as Enclosure B. Nineteen agencies responded.6/

One agency indicated that it had in the past relied on the rule of necessity to indemnify its contractors, relying on a rule of necessity recognized bythe Comptroller General in 59 Comp. Gen. 705 (1980). The agency agreed to indemnify an airline for evacuation flights from Viet Nam even though the agency did not have express statutory authority to indemnify its contractors. This agency also used the rule of necessity in agreeing to indemnify certain sea carriers during the fall of Indo China for certain liabilities. In two other instances, under comparable circumstances the agency had agreed to indemnify its contractors subject to the availability of appropriations.7/

A second agency agreed to indemnify certain of its contractors who were carrying out agency programs involving unusually hazardous risks but such indemnity was limited to available appropriations and there was no implication that Congress would at a later date appropriate funds sufficient to meet deficiencies.

A third agency involved in the testing of devices and compounds to be used by human test subjects pointed out that in their view many contractors have not been willing to contract with their agency because of the risks involved.

Two agencies identified two instances where a contractor refused to enter into a contract because of the inability of the agency to indemnify. One such contract involved air traffic control automation systems and the other involved the testing of a device by human test subjects.

There may have been and probably were other instances when contractors refused to bid on a Government contract but several of the agencies contacted commented that their records were not organized in such a way so as to indentify instances when contractors refused to enter into a contract because of the inability of the agency to indemnify. It is also clear that a

potential contractor may have simply not bid and the reason for such refusal to bid would never be communicated to the Government agency.

In summary, this survey resulted in some hard facts suporting the extension of indemnity authority to additional Government agencies where catastrophic losses may be involved even though the activity may not in itself appear to be unusually hazardous. It indicated that some Government contractors have refused to contract with an agency which did not have the authority to indemnify. Moreover, it pointed out a signficant problem faced by Government agencies who believe that a particular contract is critical and vital to its functions (e.g. utility services, obtainable from only one source, or the transport of people from combat zones where a commercial carrier was used) and can only obtain the contract if it determines that it falls within the rule of necessity as declared by the Comptroller General in 59 Comp. Gen. 705 (1980), as distinguished in Comp. Gen. B-197583, January 19, 1981. There is considerable uncertainty as to when such a determination can be made without violating the Anti-deficiency Act--31 U.S.C. 665 and 41 U.S.C. 11. Violation of the Anti-deficiency Act may result in administrative discipline and if knowingly and willfully done may result in fine and imprisonment; see 31 U.S.C 665(i). Finally, the survey indicated that appropriated funds that would otherwise be used in rare cases to pay for exorbitant insurance premiums may be instead used to accomplish the agency's mission where the agency has authority to indemnify a concerned contractor. We do, however, believe that insurance plays a vital role as explained in the following paragraph D.

D. Task Force Assessment

The Task Force believes that there is a persuasive justification for the agreement to indemnify a contractor where the contract will faciliate the national defense, as broadly defined herein, but only if an unusually hazardous or nuclear risk is involved or the contract activity may result in catastrophic losses. The Task Force has proposed, infra, that "catastrophic losses" be defined as: "losses which the particular contractor cannot reasonably protect against through private insurance or self-insurance by the payment of a reasonable premium or the establishment of or reliance on a reasonable self-insurance reserve." We believe that if the Executive Order 10789 is amended as we propose in Part IV of this report, most of the contactors who are at risk will be eligible for protection by a U.S. Government indemnity agreement and the public will be also eligible for such protection under that Executive Order.

We believe that insurance plays a vital role in assuring that the contractor will be diligent and use reasonable care in his contract performance. The requirement that a contractor obtain insurance from the commercial insurance market causes a contactor to expend substantial effort to provide a safe and reliable product or service. Insurance underwriters can provide effective quality control through the mechanism of refusing coverage. Consequently, we believe that the condition to indemnity coverage that the contractor obtain insurance , considering its availability, cost and terms, should be continued. The Executive Order E.O. 10789 currently permits other types of financial protection as may be appropriate under the circumstances. This flexibility, we believe, should be continued. What is reasonably available insurance, considering its costs and terms, must be determined ad hoc since there is a variety of factors to be considered when a contractor goes into the insurance market for a particular coverage, e.g., the insurance market loss experience for the risk involved, and the loss experience, size, financial condition and experience of the particular contactor are some of the factors that would have to be considered in determining the availability, premium and terms and conditions of the policy. To the extent insurance is not available on reasonable terms and conditions and at a reasonable premium, the Government agency should agree to indemnify a contractor under E.O. 10789 since that will result in using appropriated funds, otherwise expended unreasonably for insurance, to achieve the Government agency's mission.

To the extent E.O. 10789, as we propose it to be amended, does not entitle an Executive Agency to agree to indemnify a contractor, e.g., where catastrophic losses may result from the performance of the Government contract but the particular contract would not facilitate the national defense, the Task Force suggests that the justification for such indemnity authority be provided to the Congress by those who propose it. This could be done in connection with H.R. 1504, 97th Cong. Alternatively, with respect to particular projects it could be done in legislation which authorizes the project (e.g., swine flu vaccine--Pub. L. 94-380; Northeast Corridor Project--Pub. L. 95-335; Synefuel project of DOE--Pub. L. 96-514) or after the losses are incurred (e.g., the Texas City Explosion Relief Act--69 Stat. 707).

III. The meaning of "National Defense"

Under section 1 of Public Law 85-804, the President may:

> "***authorize any department or agency of the Government which exercises functions in connection with the national defense *** to enter into contracts or into amendments or modifications of contracts *** without regard to other provisions of law relating to the making, performance, amendment, or modification of contracts, whenever he deems that such an action would facilitate the national defense ***."
> 50 U.S.C. 1431.

A. Legislative History of Public Law 85-804 and Prior Use of that Authority

The question is whether the legislative history of Public Law 85-804 supports adding additional civilian agencies to those currently utilizing it under the implementing Executive Order.

Senate Report No. 2281, August 9, 1958, to accompany H.R. 12894, 85th Cong., 2nd. Sess. (1958 Code Cong. and Adm. News 4043) indicates that Congress recognized that the law could be used by agencies other than purely military agencies. The report specifically recognizes that under earlier extensions of the First War Powers Act, which P.L. 85-804 made permanent, the President had extended coverage to agencies such as Commerce, Agriculture, Interior, GSA and TVA.

The Committee noted:

> "Although the President has been authorized by Title II, and is authorized by this bill, to select the departments and agencies which may exercise the broad authority contained in the bill, the President was limited by Title II, and is limited by this bill, in his selection, to those departments and agencies of Government which exercise functions in connection with the national defense. Furthermore, once a department or agency has been designated by the President to exercise these powers and procedures, such department or agency may only utilize them whenever the action would facilitate the national defense. The authority contained in this bill is not, therefore, authority by which the departments and

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> agencies of Government may dispense aid solely for the benefit of contractors or subcontractors. While contractors or subcontactors may be the recipients of aid in some instances, the primary consideration is, and must be, whether such aid will facilitate the national defense."

The Senate Report does not discuss the meaning of the term "national defense" or the other operable terms such as "exercises functions in connection with the national defense" or "would facilitate the national defense." What can safely be deduced from the Senate Report is that Congress did not intend to limit the applicability of the Act to purely military agencies and that the addition of agencies beyond those listed in the Executive Order would be consistent with the intent of Congess if the President designated an agency which may exercise national defense functions. There is nothing in the report that apears to argue against taking a broad reading of what is connected to the national defense.

Similarly, the House Report No. 2232, 85th Cong., 2nd. Sess. to accompany H.R. 12894 does not address the issue in question. The report talks mainly about "military procurement" or "defense procurement." On page 7 there is language which shows that the Committee was aware that non-military agencies were operating under the First War Powers Act and Executive orders. But like the Senate Report it contains no real guidance on the extent to which civilian agencies could use the Act.

Both the House and Senate Reports and the relevant hearing state that the purpose of the legislation was to enact into permanent law authority similar to that contained in Title II of the First War Powers Act of 1941, as amended (55 Stat. 538) and as extended through June 30, 1958.8/ Title II of the First War Powers Act authorized agencies to indemnify its contractors. In the hearings and in the debates it was made clear that the authority to indemnify could be made available to Government agencies other than the Department of Defense, as it had been made available in the past under the First War Powers Act; e.g., the Department of Commerce9/ and the Department of Interior.10/

Further, the legislative history of the First War Powers Act of 1941 indicates that the authority provided in the proposed bill could be extended to "all departments of the Government engaged in the presecution of the war" and that this was "a very long step" from what was done in the past emergencies.11/ The First War Powers Act of 1941 was

characterized by Senator Vandenberg as "...a complete blanket authority to the President of the United States to authorize any department to do anything it pleases in respect to war contracts."12/

In attempting to determine whether the legislative history would support a broadening of the current Executive Order to cover additional civilian agencies, it is, perhaps, instructive to note the way the First War Powers Act was made applicable to civilian agencies by earlier Executive Orders about which one could assume the Congess was aware in 1958.

These show a somewhat mixed approach, especially during WWII. In many cases, the President brought in all the activities of any agency under the Act. In others an attempt was made to distinguish among types of contracts. In several cases), the President made a blanket determination that applying the Act to certain agencies would "facilitate the prosecution of the war" and simply made the original Executive Order 9001 of December 7, 1941 (which covered the War and Navy Departments and the Maritime Commission) applicable to all contracts of the agency (e.g., E.O. 9055, Department of Interior; E.O. 9023, Treasury, Agriculture, Panama Canal Zone, Federal Works Administration, GPO and the National Advisory Committee for Aeronautics). However, in other orders in the 1942 time frame there were sometimes limitations. For example, E.O. 9116, after extending E.O. 9001 to several agencies, qualified this as to the Federal Communications Commission with the provision "that the provisions of this order shall be applicable only to contracts relating to the prosecution of the war effort." This seems to imply that not all FCC contracts would be covered. Similar language was found in E.O. 9233 (Board of Economic Warfare), E.O. 9233 (Department of Commerce, 9219 (Office of Scientific Research and Development in the Office of Emergency Management). An even more specific limitation was included in E.O. 9253 which extended E.O. 9001 "to the Immigration and Naturalization Services, Department of Justice, with respect to the contracts made or to be made by it for the feeding and care of persons in the custody of such service..." There were several other executive orders during the WWII period and they exhibited this mixed pattern - either applying to "all contracts" or only to all contracts "relating to the prosecution of the war effort."

In 1951 a new basic Executive Order (E.O. 10210) was issued which was applicable to DOD and the Department of Commerce. This order contained language and a structure similar to the current executive order. It was followed by several additional Executive Orders granting similar powers to other agencies. These included E.O. No. 10231, TVA; E.O. 10216, Department of Agriculture, AEC, National Advisory Committee for Aeronautics , and GPO; E.O. 10227, GSA; E.O. 10298, Department of Interior; and E.O. 10281, Defense Material Production Agency. The only Executive Order issued during the period of the early 1950's that attempted to limit the scope of the order to less than all the potential activities of an agency was E.O. 10243. This order extended E.O. No. 10210 to the Federal Civil Defense Administration but only "with respect to (a) emergency and development contracts, (b) specialized contracts, (c) contracts pursuant to delegations of authority from any other Federal department or agency, and (d) contracts with respect to an activity approved pursuant to the provisions of Section 405(3) of the Federal Civil Defense Act of 1950 (Public Law 920-81st. Congress);..."

It would thus seem that at the time Congress passed Public Law 85-804 a practice had been established of including civilian agencies within the potential scope of the Act and that it was not expected that an executive order need be specific as to whether or not all activities of the agency could qualify under the Act. However, particularly since the 1951 Executive Order, it was still necessary for the agency to show that its specific use of the authority would facilitate the national defense.

In summary, the legislative history and its implementation by the President would seem to support the inclusion of additional civilian agencies under P.L. 85-804 by the President without a need to be specific as to the nature of the agencies' defense-related mission. The Executive Order could be expanded to list more agencies. However, to the extent that an agency proposes to actually use the authority to indemnify a contractor, it will still have to show a national defense nexus.

B. Judicial Decisions and Relevant Federal Statutory Definitions of National Defense

A search of the cases has revealed none interpreting the scope of the "national defense" function for the purpose of Public Law 85-804. Furthermore, none has been found delineating when a contract may properly be deemed one that facilitates national defense.

A study of current Federal statutory provisions which define "national defense" and the Federal court decisions which have interpreted the concept of "national defense" does not, in our view, limit the concept of "national defense" as contained in Pub. L. 85-804. Instead these statutes and court decisions reflect the broad range of activities that the Congress and the courts have considered as constituting national defense activities in various contexts and for various purposes.

The current statutory provisions defining "national defense" do so broadly for the purposes of establishing naval petroleum reserves,13/ defining the crime of sabotage,14/ the development of defense housing and community facilities,15/ and for establishing the breadth of the Defense Production Act of 1950.16/

While the term "national defense" has often been referred to in legislation as a reason for the Government undertaking various activities, courts have rarely expressed opinions as to what this term embraces. On one such occasion, the Supreme Court approved peacetime activity where there was no intention to use the product of such activity for the production of war materials in time of peace, but which assured that in the event of war the nation would be prepared. Thus in Ashwander v. Tennessee Valley Authority, 297 U.S. 288 (1936), when the construction of the Wilson Dam and the installation of the power plant connected with it were challenged on constitutional grounds, the Court had little trouble in rejecting this challenge by finding that the construction and installation were authorized by the War Powers for the purpose of national defense.17/

The Court noted that the dam and power plant were constructed and installed under the authority of section 124 of the National Defense Act of June 3, 1916, and that this provision:

> ****authorized the President to cause an investigation to be made in order to determine 'the best, cheapest, and most available means for the production of nitrates and other products for munitions of war'; to designate for the exclusive use of the United States 'such site or sites upon any navigable or nonnavigable river or rivers or upon the public lands, as in his opinion will be necessary for

carrying out the purposes of this Act'; and 'to construct, maintain and operate' on any such site 'dams, locks, improvements to navigation, power houses, and other plants and equipment or other means than water power as in his judgment is the best and cheapest, necessary or convenient for the generation of electrical or other power and for the production of nitrates or other products needed for munitions of war and useful in the manufacture of fertilizers and other useful products.' The President was authorized to lease, or acquire by condemnation or otherwise such lands as might be necessary and there was further provision that 'The products of such plants shall be used by the President for military and naval purposes to the extent that he may deem necessary, and any surplus which he shall determine is not required shall be sold and disposed of by him under such regulations as he may prescribe.'***

" We may take judicial notice of the international situation at the time the Act of 1916 was passed, and it cannot be successfully disputed that the Wilson Dam and its auxiliary plants, including the hydro-electric power plant, are, and were intended to be, adapted to the purposes of national defense.

"While the District Court found that there is no intention to use the nitrate plants or the hydro-electric units installed at Wilson Dam for the production of war materials in time of peace, 'the maintenence of said properties in operating condition and the assurance of an abundant supply of electric energy in the event of war, constitute national defense assets.' This finding has ample support." 297 U.S. 326-328.

Thereafter, in construing the term "national defense" for the purpose of determining the application of the Espionage Act of June 15, 1917,[18] to certain activities, the Court held that it was:

"***a generic concept of broad connotations, referring to the military and naval establishment and the related activities of national preparedness." Emphasis supplied. Gorin v. United States, 312 U.S. 19, 28 (1940).

Furthermore, the Foreign Agents Registration Act of 1938, as amended, has been upheld on the grounds that it was national defense legislation since actions authorized under this power included the taking of preventative measures against activities that may cause international misunderstanding which may lead to war. United States v. Peace Information Center, 97 F. Supp. 255, 261 (D.D.C., 1951).

Using these decisions as our reference point, it can be argued that a national defense function is clearly one which relates to the military and naval establishments; or to preparing the nation to deal with any conceivable conflict; or to preventing a conflict from ever taking place.

Additionally, it appears that grants of authority under statutes relating to national defense will be construed in conformity with the general rules of statutory construction and that they will be reasonably and liberally construed to accomplish their objectives, United States v. Montgomery Ward & Co., 150 F. 2d 369, 377 (7th Cir., 1945), vacated on other grounds with an order to dismiss as moot, 326 U.S. 690; United States v. Krupnick, 51 F. Supp. 982, 985 (D.N.J. 1943); and their application will not be impeded by technical interpretations. Montgomery Ward & Co., supra, 378. Further, the scope of national defense legislation should not be limited by implication, United States v. Domres, 142 F. 2d 477, 479 (7th Cir., 1944), cert. den. 323 U.S. 723; Brown v. Bernstein, 49 F. Supp. 728, 733 (D.C.M.D. Pa., 1943).

Applying these rules of construction to Pub. L. 85-804 would indicate that the President could broadly exercise his discretion in determining which agencies perform a national defense function and, in turn, these agencies could broadly exercise their discretion in determining which of their contracts facilitated a national defense purpose.

We are cognizant of the fact, that notwithstanding the above, at least one court has held that, for purposes of eligibility for workmen's compensation benefits under the Defense Base Act, pure scientific research conducted under grants from NASA and NSF did not have such a defense nexus so as to bring the death of the microbiologist conducting the research within the ambit of section 1 of the Defense Base Act. University of Rochester v. Hartman, 618 F. 2d 170 (2nd Cir., 1980). However, the court in making this determination relied heavily upon the characterization given the research by the agencies involved and relied upon a narrower construction of the term "national defense activity" than is required by the decisions discussed above.19/ One can only speculate as to what would have been the court's position had the agencies involved taken the position that the research in question was related to national defense. In any event, this decision would not appear to constitute a limitation on what can be considered to be a defense related contract under Pub. L. 85-804.

It is relevant we believe to note that in the past, Congress has exercised its "war powers" under the Constitution during peacetime to accomplish a scope of activities that were at best indirectly related to the preparation for war or to the conduct of war; for example, the Congress has enacted legislation during peacetime or to be effective during peacetime in the exercise of its war power to educate our citizenry (72 Stat. 1580); to prohibit the sale of intoxicants (40 Stat. 1046) to rehire persons inducted for military service (38 U.S.C. 2021), to construct interstate highways (23 U.S.C. 101(b); to construct dams and power plants for the production of nitrates (39 Stat. 215); to create the AEC to oversee and further the research and development and control of atomic energy for both military and civil purposes (60 Stat. 755); and to tax excess profits of defense contractors (65 Stat. 7). By analogy to the exercise of war powers in time of peace, we contend that the President has authority to apply Pub. L. 85-804 to Government agencies and departments that perform functions directly or indirectly related to the national defense, i.e., functions which have the purpose of protecting or strengthening the national health, safety, welfare and economy.

We believe that, based on the previously discussed legislative history of Public Law 85-804 and the legislative and judicial definition of "national defense," the President may identify in accordance with 50 U.S.C. 1431, all Executive Agencies[20] and Military Departments[21] of the United States as having the potential of exercising functions in connection with the national defense. Based on this precedent, where the national health, safety, welfare or economy are part of the responsibilities of an agency or department, to that extent we believe that an agency or department may perform a function in connection with the national defense.

In addition, we believe that the heads of these Government agencies may, pursuant to 50 U.S.C. 1431, broadly exercise their delegated authority to provide for the indemnification of a contractor whenever "...he deems that such an action would facilitate the national defense...." Where a contract may have a substantial connection with and facilitate the national health, safety, welfare or economy, we believe the head of an Executive Agency may determine based on the particular circumstances that the agreement to indemnify that contractor would facilitate the national defense.

IV. Recommended Revision of E.O. 10789

We recommend that Executive Order No. 10789, as amended, which is Enclosure C to this report, be amended in the following respects.

A. Amendment 1

Revise Part I, paragraph 1.A.(a), second sentence to read:

> "This exception from the limitations of paragraph 1 shall apply only to claims or losses arising out of or resulting from risks that the contract defines as (1) unusually hazardous or nuclear in nature or (2) giving rise to the possibility of catastrophic losses; i.e., losses which the particular contractor cannot reasonably protect against through private insurance or self-insurance by the payment of a reasonable premium or the establishment of or reliance on a reasonable self-insurance reserve."

Analysis of Amendment 1

This revision would permit for the first time an eligible agency to authorize the indemnification of a contractor if the head of the agency determines that the risks under the particular contact give rise to the possibility of catastrophic losses." The revision then defines the term "catastrophic losses" as indicated in the above amendment. The primary purpose of the amendment is to permit eligible agencies to use the indemnification authority in contracts to an extent coextensive with the Congressional intent. The current E.O. 10789 required a finding that a contract must involve an unusually hazardous or nuclear risk and this resulted in limiting the use of the indemnity authority. Agencies for various reasons had refused to describe their activities as "unusually hazardous." The Task Force believes that based on the legislative history of Pub. L. 85-804, the President could properly revise the Executive Order as now proposed and sought the confirmation of the Office of Legal Counsel, Department of Justice.

In Enclosure D to this report, On October 28, 1981, the Office of Legal Counsel in concept agreed that the President would have authority to revise the order as proposed. The proposed definition of "catastrophic losses" and its focus on available commercial insurance is based on the legislative history of Pub. L. 85-804 as indicated in Enclosure D and in H. Report 2232, 85th Cong. pp. 6, 9; S. Report 2281 85th Cong; and House Hearings before Subcommittee No. 4 of the Committee on the Judiciary on H.R. 12894, 88th Cong, pp 5-13.

B. Amendment 2

Revise Part II, paragraph 21 by renumbering that paragraph 21A and by adding a new paragraph 21B reading as follows:

"21B. Subject to the limitations and regulations contained in paragraphs 1 to 14, inclusive, hereof, and under any regulations prescribed by him in pursuance of the provisions of paragraph 22 hereof, the head of each of the following-identified agencies is authorized to perform or exercise as to his agency, independently of any Secretary referred to in the said paragraphs 1 to 14, the authority described in paragraphs 1 and 1A hereof to provide in a contract provision that the United States will hold harmless and indemnify the contractor against specified claims or losses as set forth therein:

Each Executive Agency of the United States as defined in 5 U.S.C. 105."

Analysis of Amendment 2

As indicated in this Task Force report, we believe there is a need to authorize additional Government agencies to indemnify their contractors, to the extent that contact work is directly or indirectly related to the national defense and the current commercial insurance market is unable to reasonably protect the Government contractor and the public. Moreover, we believe that each "Executive Agency" has the potential of exercising functions in connection with the national defense. Consequently, the Task Force recommends that the President identify in paragraph 21B all Executive Agencies as being eligible to exercise the authority to indemnify a contractor, subject to the limitations and conditions provided in the Executive Order. A list of Executive Agencies is identified in Enclosure E--a copy of the "Contents" of The United States Government Manual 1981/82.

The Task Force has not studied the need for nor is it prepared to recommend that all the authority provided under Pub. L. 85-804 should be delegated to all Executive Agencies. Only the authority to indemify would be delegated under the recommendation.

C. Amendment 3

Revise paragraphs 22 and 23 of the E.O. 10789 by adding after the terms "agency named" the terms "or identified."

Analysis of Amendment 3

By adding the terms "or identifed" this would make paragraphs 22 and 23 conform to the new paragraph 21B which identifies agencies given indemnity authority as executive agencies described in 5 U.S.C. 105 but does not name them.

Washington, D.C. 20530

January 20, 1982

DISSENT

I must dissent from the Report of the OFPP Interagency Task Force on Indemnification, Part I, regarding indemnification of government contractors against third-party liability claims. The extension of Executive Order 10789 which the Report proposes would represent an unjustified expansion of the circumstances in which the United States would assume liability for personal injuries or deaths resulting from the acts or omissions of contractors with the United States, rather than from the acts or omissions of federal officers or employees. Moreover, the proposed amendments to the Executive Order would tend to deter contractors from acting with due care in the performance of their contractual obligations. Therefore, and as briefly discussed below, I recommend that Executive Order 10789 remain in its present form and that the substantive amendments proposed not be enacted.

(1) The Report does not calculate the increased cost to the United States of assuming responsibility for catastrophic losses caused by the acts or omissions of contractors. Presumably, the potential for increased liability is large given the main thrust of the proposals. The advisability of proposing a large but uncertain increase in the exposure of the United States to liability has not been adequately addressed, counseling against enactment of the proposals.

Executive Order 10789 permits (Part I, para 1) indemnification clauses to form a part of contracts entered into pursuant to the Order without regard to available appropriations. Because the Order permits assumption of uncertain future liability, not subject to the limitations of the Anti-deficiency Act, its provisions should be limited so that they can be invoked only in carefully defined and limited circumstances. The Report, however, would expand availability of the extraordinary authority without calculating the cost associated with the proposals. This is not the course that prudence dictates.

(2) There has been no showing that the existing provisions of the Executive Order do not suffice to enable the government to contract for goods to the extent it is necessary to do so in order to serve the national defense. While there can be no doubt but that the modifications proposed by the Report are permitted by the broad terms of P.L. 85-804 (see the October 26, 1981 letter from Theodore B. Olson, Assistant Attorney General, Office of Legal Counsel), the advisability of this expansion of its terms is dubious if the intended purpose of Executive Order 85-804 is considered. For instance, the legislative history reflects the congressional intent to permit national defense supplies to be obtained in circumstances where they could not otherwise be obtained. U.S. Code Congressional Administrative News, 85th Cong. 2d Sess., Vol. 2, p. 4043 (1958) (setting forth Senate Report No. 2281). Similarly, the Court of Claims has construed the purpose of the legislation upon which P.L. 85-804 is explicitly based, the First War Powers Act. In Bofinders Co. v. United States, 153 F. Supp. 381 (Ct. Cl. 1957), cert denied, 355 U.S. 953, the Court held that this legislation "was not passed for the benefit of contractors or for their relief from an unprofitable contract, but solely for the benefit of the nation as a whole, in order to facilitate the prosecution of the war." Since the proposals are not enacted against the backdrop of any need to have additional authority to require contractors to perform work, there does not appear to be an adequate justification for the amendments in the intended purpose of P.L. 85-804.

(3) The effect of the proposed amendments to the Executive Order would be to render the United States liable without regard to the negligence or lack of negligence of government officers or employees under circumstances where the contractor would be liable for damages sounding in tort. Thus, the proposals would abrogate the indemnity principle "accepted with virtual unaminity amoung American jurisdictions . . . . [which precludes a party] to cast the burden of negligent actions upon those who were not actually at fault . . . ." United States v. Seckinger, 397 U.S. 203, 211-212 (1970). Since the general intent of Congress in enacting legislation providing for governmental assumption of liability for torts "is to waive immunity from recognized causes of action and . . . not to visit the Government with novel and unprecedented liabilities," the expansion of governmental liability as proposed should not be enacted unless a judgment is made that the heretofore generally accepted principles and legislative enactments are unsound. No showing has been made to that effect.

(4) In addition, the proposals would permit the United States to be held responsibile for activities of contractors as a matter of course regardless of whether they are deemed to be pursuant to a government program deemed to be "unusually hazardous" in nature· in fact, one of the main thrusts of the proposal appears to be expansion of use of E.O. 10789 to hazardous activities which do not meet this criterion. Plainly, the Congress has heretofore intended that the United States normally shall not be liable for unusually hazardous activities, simply because of the nature of the activity, but instead has intended "to exclude liability based solely on the ultrahazardous nature of an activity undertaken by the Government." Laird v. Nelms, 406 U.S. 797, 801 (1972). Whether the liability for which the United States is to assume responsibility under the proposals is deemed "ultra-hazardous" or "negligent" activity of persons other than federal officers or officials, the general policies reflected in legislation counsel against such a course in the absence of specific legislative consideration of the need for such a drastic shift in the general balance of responsibilities.

Moreover, the shifting of tort liability from those persons directly responsible for any injuries undermines the function of tort liability as a means of causing a person to act with due care. No adequate basis for relieving contractors from responsibility for their actions has been stated nor has the Report discussed the advisability of abrogating the financial incentive for complying with duties which the law has developed in order to provide an incentive to act safely to prevent the injuries and wrongful deaths for which the Report would assume financial responsibility.

For all of the foregoing reasons, the proposed modifications in the Executive Order are unsound and should not be enacted. I therefore dissent from the majority report.

JEFFREY AXELRAD
Department of Justice

FOOTNOTES

1/ The establishment of the Task Force was suggested in the letter of June 12, 1981, from the NASA General Counsel to the Administrator of OFPP. This letter is enclosed as Enclosure A. The impetus for the study on indemnification was, as suggested in Enclosure A the Commission on Government Procurement's Recommendation H-5 and more recently the request of the House Committee on Science Technology in House Report No. 97-32.

Recommendation H-5 provided: "Enact legislation to provide Government indemnification, above the limit of available insurance, of contractors for liability damage arising from a catastrophic accident occurring in connection with a Government program."

House Report No. 97-32, page 24 in relevant part stated:

"INDEMNIFICATION OF CONTRACTORS BY NASA AGAINST THIRD PARTY LIABILITY

"The Committee believes that NASA should provide third party liability indemnification to space systems contractors whenever feasible and in the best interest of the United States Government. The Committee recognizes NASA's close involvement in the total procurement process including NASA's spacecraft performance specifications, design, manufacture and reliability assessment. The Committee would envision that when it is in the best interest of the United STates Government NASA would specify a required amount of contractor-obtained liability insurance coverage with additional indemnification to be provided by NASA. The Committee requests that NASA assign responsibilities to the General Counsel to coordiate an indemnification policy with the cognizant Executive Agencies and report its findings to the Committee no later than September 1, 1981. Section 308 of the National Aeronautics and Space Administration Act of 1958 as amended by Public Law 96-48 should be used as a guideline in developing Executive Order changes wherever practicable."

2/ The impetus for this objective was the Commission on Government Procurement's Recommendation H-4 which provided: "Enact legislation to assure prompt and adequate compensation for victims of catastrophic accidents occurring in connection with Government programs."

3/ Report of the COGP, Vol. 4, Part H, p. 22.

4/ Id. pp. 101-103.

5/ See footnote 1 for the complete text of the House Committee's recommendation.

6/ The nineteen agencies that responded were AID, Commerce, Committee for Blind and Handicapped, DOE, EPA, FTC, GSA, HHS, HUD, International Communications Agency, Justice, Navy, NASA, OPM, Transportation, Treasury, TVA, VA, and USAF.

7/ It is striking that Congressman Cellar, Chairman of the Judiciary Committee, in the debates explained the purposes of Pub. L. 85-804 and indicated that one of the prior uses of the authority given by the First War Powers Act (55 Stat. 838), the predecessor to Pub. L. 85-804, to be:

"This bill would permit the Government to enter into indemnification agreements. These agreements are normally for the risk in excess of that available from private insurance sources. Indemnification authority was also used in connection with the airlift by commercial planes of troops and supplies to Korea in the early days of that conflict. Since it is impossible to draft legislation which will cover every conceivable situation perfectly and at the same time provide the necessary flexibility, much depends upon the administration of the act." (104 Cong. Rec. 15473)

We note further that the Comptroller General in 59 Comp. Gen. 369 (1980) appeared to hold that an agreement to indemnify which is made subject to the appropriation of funds by Congress violates the spirit of the Anti-Deficiency Act--31 U.S.C. 665(a). The Comptroller General described such a commitment as a "coercive deficiency."

8/ See Senate Report 2281 and House Report 2232, 85th Cong. and H. Hearings before Subcommittee No. 4 of the Committee on Judiciary on H.R. 12894, 85th Cong., 2d Sess. p. 3.

9/ See H. Hearings footnote 8, supra, p. 91 and 104 Cong. Rec. 15472.

10/ See H. Hearings footnote 8, supra, p.92.

11/ See Mr. Hancock, 87 Cong. Rec. 9861.

12/ See 87 Cong. Rec. 9842.

13/ 10 U.S.C. 7420(a)(1) states: "[N]ational defense" includes the needs of, and the planning and preparedness to meet essential defense, industrial and military emergency energy requirements relative to the national safety, welfare and economy, particularly resulting from foreign military or economic actions...."

14/ See 18 U.S.C. 2151 for a lengthy definition of "national defense material," "national-defense premises" and "national-defense utilities." Each definition provides a list of items but each definition is not apparently all encompassing since it is introduced by the term "include" rather than "means."

15/ 42 U.S.C. 1592 (e) states: "National defense shall mean (1) the operations and activities of the armed forces, the Atmomic Energy Commission, or any other Government department or agency directly or indirectly and substantially concerned with the national defense, (2) other operations and activities directly or indirectly and substantially concerned with the operations and activities of the armed forces and the Atomic Energy Commission, (3) activities in connection with the Mutual Defense Assistance Act of 1949, as amended, or (4) the provision of community facilities or services necessary to the health, safety, or public welfare of the inhabitants of a town or community which has been relocated as a result of the acquisition (through eminent domain or purchase in lieu thereof) of its former site by or on behalf of the Atomic Energy Commission for national-defense activities."

16/ For purposes of the entire Defense Production Act of 1950, 50 U.S.C. App. 2061-2069 the Act defines "national defense" at 50 U.S.C. App. 2152(d) as: "The term 'national defense' means programs for military and atomic energy production or construction, military assistance to any foreign nation, stockpiling, space, and directly related activity."

In addition, 50 U.S.C. App. 2282 states that for purposes of Title II of the Defense Production Act, the terms "national defense" are to be "construed to include 'civil defense' as defined in this Act [sections 2251 to 2297 of this Appendix]."

17/ The controversy centered around the validity of a contract between TVA and the Alabama Power Company for TVA's acquisition of power transmission lines and other property and for the sale of TVA's surplus electricity.

18/ 40 Stat. 217.

19/ The court stated that:

> **** Viewing the facts of the instant case from this perspective, it is patent that Professor Vishniac's fatal trip to Antarctica was was not part of any *** national defense activity.3/ ****

In the footnote "3/" the court stated:

> "There is no basis for the claimant's argument that Professor Vishniac's basic research into soil microbiology was connected with our national defense. Qualified witnesses testified at the administrative hearing that Professor Vishniac's research was completely unrelated to the Defense Department and lacked any potential military use. *** Indeed, the United States' presence in Antarctica is limited to purely scientific research pursuant to the terms of the Multilateral Antarctic Treaty *** and for the United States to conduct any activities there related to war or national defense would constitute a violation of the Treaty ." Hartman, supra, 174.

20/ 5 U.S.C. 105 defines "Executive agency" as meaning an Executive department, a Government corporation, and an independent establishment. In turn, these are defined in 5 U.S.C. 101, 103 and 104. A listing of Government corporations and Independent establishments is contained in The United States Government Manual 1981/1982, which is enclosed as Enclosure E.

21/ The Military Departments are defined in 5 U.S.C. 102 as the Department of the Army, Navy and Air Force.

NASA
National Aeronautics and
Space Administration

Washington, D C
20546

Coleman
Copy to Dr.

G (81-32051)

JUN 12 1981

Mr. Donald E. Sowle
Administrator for Federal
Procurement Policy (Designate)
New Executive Office Building
726 Jackson Place, NW
Washington, DC 20503

Dear Mr. Sowle:

The House Committee on Science and Technology in H.R. 97-32, page 24 (copy enclosed), requested that I, in my capacity as General Counsel of NASA, coordinate an indemnification policy with cognizant Executive Agencies and report back the Executive Agencies' findings to the Committee no later than September 1, 1981. The Committee believed that NASA should provide third party liability indemnification to NASA space systems contractors whenever feasible and in the best interest of the United States. The Committee suggested that section 308 of the National Aeronautics and Space Act of 1958, as amended by Pub. L. 96-48 (42 U.S.C. 2458b), be used as a guide (copy enclosed) "in developing Executive Order changes wherever practicable." I believe this reference to Executive Order changes is a reference to Executive Order 10789, as amended, which was issued under Pub. L. 85-804 and authorizes U.S. Government agencies to indemnify its contractors under certain limited circumstances. Thus, the Committee envisages the development of an indemnification policy which affects other agencies of the U.S. Government as well as NASA.

I request your assistance in developing an Executive Agency position on indemnification of U.S. Government contractors. I suggest that an intra-agency task group, including a Department of Justice and NASA representative, be established by OFPP for that purpose. The attempt to develop such a position would probably dovetail with OFPP's review of the current Executive Agency position on indemnification of U.S. Government contractors.

If, as a result of the inter-agency review, there is a recommended change in the indemnification of U.S. Government contractors, this would require at a minimum revision of Executive Order 10789, as amended, or the enactment of additional legislation.

Encl. A

Please let me know what assistance NASA can lend to the development of an Executive Agency position on indemnification of U.S. Government contractors. My phone number is 755-3875. I appreciate your assistance.

Sincerely,

S. Neil Hosenball

S. Neil Hosenball
General Counsel

Enclosures

97TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
1st Session } { No. 97-32

AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR FISCAL YEAR 1982

MAY 8, 1981.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. FUQUA, from the Committee on Science and Technology, submitted the following

REPORT

together with

MINORITY VIEWS

[To accompany H.R. 1257]

[Including cost estimate and comparison of the Congressional Budget Office]

The Committee on Science and Technology, to whom was referred the bill (H.R. 1257) to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes, having considered the same, report favorably thereon with amendments (shown in italic in the bill accompanied by this report) and recommend that the bill, as amended, do pass.

The amendments are as follows:

Page 2, line 1, strike out "$2,230,000,000" and insert "$2,134,000,000".
Page 2, line 2, strike out "$1,043,000,000" and insert "$903,900,000".
Page 2, line 4, strike out "$451,400,000" and insert "$350,400,000".
Page 2, line 5, strike out "$256,100,000" and insert "$215,200,000".
Page 2, line 7, strike out "$472,900,000" and insert "$410,900,000".
Page 2, line 8, strike out "$14,600,000" and insert "$12,600,000".
Page 2, line 10, strike out "$323,600,000" and insert "$276,000,000".
Page 2, line 12, strike out "$141,000,000" and insert "$129,300,000".
Page 2, line 13, strike out "$4,400,000" and insert "$2,000,000".
Page 2, line 14, strike out "$435,200,000" and insert "$400,200,000".
Page 2, strike out lines 19 and 20.
Page 2, line 21, strike out "(3)" and insert "(2)".
Page 2, line 23, strike out "(4)" and insert "(3)".

budget underwent major revisions in a matter of weeks just before our authorization process had to begin. For example, there was no time for consultation with the space science community on the impacts of the budget revision. The guaranteed availability of a continuing advisory committee apparatus with cognizance of all NASA programs would provide the Congress with a very useful source of advice having a broad perspective and current information. To summarize, the Committee feels the Agency has not always been forthcoming with information and seeks this way of ensuring that at least another potential source is always available.

The Committee request is not intended to interfere with the organization of existing advisory committees. The request would impact their operations only in the following ways: (1) They would be able to set their own agendas and terms of discussion (at least in part) rather than having this done totally by NASA; (2) They would respond to questions and issues raised by this Committee; (3) They would make an annual report to the Congress.

The Administrator should continue to appoint as members of the advisory committees highly qualified individuals whose advice and counsel will be useful to him and to the Congress. Insofar as possible the Committees should be broadly representative of the space community and should be from diverse geographic areas.

The Committee recognizes the existence of other independent advisory groups such as the Space Science Board of the National Academy of Sciences. Clearly, this new request would in no way supplant them or reflect adversely on them. Such groups advise other government agencies as well as NASA, and are responsible to their parent organizations. Thus, they provide counsel from a different vantage point. Their advice has been useful to this Committee in the past and we look forward to their continued wise assistance.

INDEMNIFICATION OF CONTRACTORS BY NASA AGAINST THIRD PARTY LIABILITY

The Committee believes that NASA should provide third-party liability indemnifications to space systems contractors whenever feasible and in the best interest of the United States Government. The Committee recognizes NASA's close involvement in the total procurement process including NASA's spacecraft performance specifications, design, manufacture and reliability assessment. The Committee would envision that when it is in the best interest of the United States Government NASA would specify a required amount of contractor-obtained liability insurance coverage with additional indemnification to be provided by NASA. The Committee requests that NASA assign responsibilities to the General Counsel to coordinate an indemnification policy with the cognizant Executive Agencies and report its findings to the Committee no later than September 1, 1981. Section 308 of the National Aeronautics and Space Administration Act of 1958 as amended by Public Law 96–48 should be used as a guideline in developing Executive Order changes wherever practicable.

Public Law 96-48
96th Congress

An Act

To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities and research and program management, and for other purposes

Aug. 8, 1979
[H.R. 1796]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration to become available October 1, 1979:

National Aeronautics and Space Administration Authorization Act, 1980

(a) For "Research and development," for the following programs:

(1) Space Shuttle, $1,546,000,000;

(2) Space flight operations, $463,300,000;

(3) Expendable launch vehicles, $[illegible],700,000;

(4) Physics and astronomy, $337,500,000;

(5) Planetary exploration, $220,200,000;

(6) Life sciences, $45,900,000;

(7) Space applications, $336,300,000;

(8) Technology utilization, $12,100,000;

(9) Aeronautical research and technology, $309,300,000;

(10) Space research and technology, $119,400,000;

(11) Energy technology, $5,000,000; and

(12) Tracking and data acquisition, $332,800,000.

(b) For "Construction of facilities," including land acquisition, as follows:

(1) Modification of static test facility, Ames Research Center, $2,900,000;

(2) Construction of large aircraft maintenance dock, Hugh L. Dryden Flight Research Center, $1,500,000;

(3) Rehabilitation and modification of flight operations facilities, Ellington Air Force base, $1,700,000;

(4) Modifications to central instrumentation facility, John F. Kennedy Space Center, $1,260,000;

(5) Modifications to operations and checkout building, John F. Kennedy Space Center, $950,000;

(6) Rehabilitation of roof, launch control center, John F. Kennedy Space Center, $600,000;

(7) Modifications of model support system 8-foot high temperature structures tunnel, Langley Research Center, $1,410,000;

(8) Modifications to 8-foot transonic pressure tunnel, Langley Research Center, $2,000,000;

(9) Modification of transonic dynamics tunnel, Langley Research Center, $970,000;

(10) Rehabilitation and modification of gas dynamics laboratory, Langley Research Center, $3,600,000;

(11) Modifications to central air system, various buildings, Lewis Research Center, $5,700,000;

(12) Modifications to various buildings, Marshall Space Flight Center, $2,640,000;

(13) Rehabilitation of roofs, various buildings, Marshall Space Flight Center, $900,000;

unless (A) a period of 30 days has passed after the Administrator or his designee has transmitted to the Speaker of the House of Representatives and to the President of the Senate and to the Committee on Science and Technology of the House of Representatives and to the Committee on Commerce, Science, and Transportation of the Senate a written report containing a full and complete statement concerning (1) the nature of such construction, expansion, or modification, (2) the cost thereof including the cost of any real estate action pertaining thereto, and (3) the reason why such construction, expansion, or modification is necessary in the national interest, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 4. Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Technology or the Senate Committee on Commerce, Science, and Transportation,

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by subsections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee,

unless (A) a period of 30 days has passed after the receipt by the Speaker of the House of Representatives and the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

Federal research funds geographical distribution
42 USC 2459 note

SEC. 5. It is the sense of the Congress that it is in the national interest that consideration to be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

SEC. 6. (a) Paragraph 13 of subsection (c) of section 203 of the National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2473(c)(13)), is amended by striking out "$5,000" where it appears and inserting in lieu thereof "$25,000".

42 USC 2459

(b) The National Aeronautics and Space Act of 1958, as amended, is amended (1) by redesignating section 306 as section 309 thereof, and (2) by inserting the following new section:

"INSURANCE AND INDEMNIFICATION

Liability insurance
42 USC 2458b

"SEC. 308. (a) The Administration is authorized on such terms and to the extent it may deem appropriate to provide liability insurance for any user of a space vehicle to compensate all or a portion of claims by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle. Appropriations available to the Administration may be used to acquire such insurance, but such appropriations shall be reimbursed to the maximum

extent practicable by the users under reimbursement policies established pursuant to section 203(c) of this Act.

42 USC 2473 note, p. 343

"(b) Under such regulations in conformity with this section as the Administrator shall prescribe taking into account the availability, cost and terms of liability insurance, any agreement between the Administration and a user of a space vehicle may provide that the United States will indemnify the user against claims (including reasonable expenses of litigation or settlement) by third parties for death, bodily injury, or loss of or damage to property resulting from activities carried on in connection with the launch, operations or recovery of the space vehicle, but only to the extent that such claims are not compensated by liability insurance of the user: *Provided*, That such indemnification may be limited to claims resulting from other than the actual negligence or willful misconduct of the user.

"(c) An agreement made under subsection (b) that provides indemnification must also provide for—

"(1) notice to the United States of any claim or suit against the user for the death, bodily injury, or loss of or damage to the property; and

"(2) control of or assistance in the defense by the United States, at its election, of that suit or claim.

"(d) No payment may be made under subsection (b) unless the Administrator or his designee certifies that the amount is just and reasonable.

"(e) Upon the approval by the Administrator, payments under subsection (b) may be made, at the Administrator's election, either from funds available for research and development not otherwise obligated or from funds appropriated for such payments.

"(f) As used in this section— Definitions

"(1) the term 'space vehicle' means an object intended for launch, launched or assembled in outer space, including the Space Shuttle and other components of a space transportation system, together with related equipment, devices, components and parts;

"(2) the term 'user' includes anyone who enters into an agreement with the Administration for use of all or a portion of a space vehicle, who owns or provides property to be flown on a space vehicle, or who employs a person to be flown on a space vehicle; and

"(f) the term 'third party' means any person who may institute a claim against a user for death, bodily injury or loss of or damage to property.".

Effective date 49 USC 2458b note. Short title.

(c) This section shall be effective October 1, 1979.

SEC. 7. This Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1980".

Approved August 8, 1979.

LEGISLATIVE HISTORY

HOUSE REPORTS: No. 96-52 (Comm. on Science and Technology) and No. 96-371 (Comm. of Conference).

SENATE REPORTS: No. 96-27 (Comm. on Commerce, Science, and Transportation) and No. 96-252 (Comm. of Conference).

CONGRESSIONAL RECORD, Vol. 125 (1979):

Mar. 28, considered and passed House.

June 14, considered and passed Senate, amended.

July 25, Senate agreed to conference report.

July 27, House agreed to conference report.

OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

OFFICE OF FEDERAL PROCUREMENT POLICY

AUG 10 1981

MEMORANDUM FOR: Office of Federal Procurement Policy Agency Contact Points

FROM: Interagency Task Group on Indemnification
Office of Federal Procurement Policy

SUBJECT: Indemnification of Government Contractors

We need your help in determining whether this task group should support a proposal to indemnify Government contractors for liability arising out of Government programs.

More than four years ago, on March 9, 1977, the Office of Federal Procurement Policy requested of selected agencies their comment on a report of a task group which recommended legislation to deal with the Commission on Government Procurement (COGP) Recommendation H-5. This COGP recommendation stated:

> "H.5. Enact legislation to provide Government indemnification, above the limit of available insurance, of contractors for liability damage arising from a catastrophic accident occurring in connection with a Government program."

Agency comments on this recommended legislation were studied by OFPP, but OFPP at that time, for various reasons, did not seek the introduction of legislation in Congress.

Today there is a renewed interest in determining whether COGP recommendation H-5 should be implemented. For example, House Report 97-32, page 24, recommended that:

> "NASA should provide third-party liability indemnifications to space systems contractors whenever feasible and in the best interest of the United States Government.... The Committee requests that NASA ... coordinate an indemnification policy with the cognizant Executive Agencies and report the findings to the Committee no later than September 1, 1981."

Now we have a new opportunity to deal with the COGP recommendation H-5 and ask that you respond to the following questions [illegible] September [illegible]. Your response will be used by the task group in determining whether we should support COGP recommendation H-5.

Enclosure B

1. Identify those instances, since January 1, 1969, when a potential bidder on a Government contract refused to bid or dropped out of negotiations because of the risk of liability arising out of contract performance.

2. Describe those instances since January 1, 1969, when your agency was compelled to agree to indemnify a contractor from third party liability in order to procure needed materials or services. Identify separately those instances when your agency relied on statutory authority (including Public Law 85-804, as implemented by Executive Order 10789, as amended) which specifically authorize indemnification from those instances, as illustrated in the enclosed Comptroller General Decision, B-194983 of September 3, 1980, when your agency did not rely on such specific statutory authority to indemnify but relied upon a rule of necessity.

3. Describe those instances since January 1, 1969, when your agency agreed to indemnify a contractor for liability not in excess of available appropriations for the purpose of saving Government money.

Please forward responses to the Indemnification Task Group, Office of Federal Procurement Policy, Room 9013, New Executive Office Building, 726 Jackson Place, N. W., Washington, D. C. 20503.

William S. Coleman, Jr.

Robert J. Wojtal
Co-Chairmen

Enclosure

FILE: B-194983 DATE: September 3, 1980

MATTER OF: Government indemnification of public utilities against loss arising out of sale of power to Government.

DIGEST: General Services Administration (GSA) may procure power under tariff or contract requiring customer to indemnify utility against liability arising from delivery of power. GSA has authority to procure power for Government under tariffs. Where no other practical source exists, tariff requirement is applied uniformly to purchases, without singling out Government, and risk of loss is remote, GAO will interpose no objection to existing practice of agreeing to tariff, with indemnity requirement, nor to proposed contract with similar indemnity provision. However, GSA should report situation to Congress.

This decision concerns the propriety of agreement by the General Services Administration (GSA) to certain indemnity provisions in procuring public utility services for Government agencies and establishments pursuant to section 201(a) of the Federal Property and Administrative Services Act of 1949, as amended.

GSA states in its request for our decision:

"Increasingly, the public utilities are attempting to insert an indemnity provision which, among other things, holds the Government liable to protect and save the utility companies harmless and indemnified from injury or damage to persons and property occasioned by the provision of the utility services.

"A typical indemnification provision reads as follows:

"'Customer assumes all responsibility for the electric power and energy delivered hereunder

PUBLISHED DECISION
59 Comp. Gen. 705

> after it leaves company's lines at the point of delivery, as well as for the wires, apparatus and appurtenances used in connection therewith where located at or beyond the point of delivery; and Customer hereby agrees to protect and save Company harmless and indemnified from injury or damage to persons and property occasioned by such power and energy or by such wires, apparatus and appurtenances located at and beyond said point of delivery, except where said injury or damage shall be shown to have been occasioned by the negligence of Company or its contractors. Further, Company shall not be responsible for injury or damage to anyone resulting from the acts of the employees of Customer or of Customer's contractors in tampering with or attempting to repair and/or maintain any of Company's lines, wires, apparatus or equipment located on Company's side of the point of delivery; and Customer will protect, save harmless and indemnify Company against all liability, loss, cost, damage and expense, by reason of such injury or damage to such employee or to any other person or persons, resulting from such acts of Customer's employees or contractor.'"

GSA also points out that:

> "In many instances, the public utilities will not consent to any contract without an agreement by the Government to indemnify or protect the public utility from liability in case of injury or property damage. * * *
>
> "The companies argue that they are required to include liability or indemnity provisions by the tariffs under which they provide utility services. They hold that they cannot legally provide the services without such protection."

With respect to the latter argument, the Supreme Court has ruled several times that such provisions in the rate schedule cannot preclude the Government from negotiating contracts for utility service which would omit the indemnification provision. (See Public Utilities Commission of California v. United States, 355 U.S. 534 (1958); Paul v. United States, 371 U.S. 245 (1963);

B-194983

United States v. Georgia Public Service Commission, 371 U.S. 285 (1963).

GSA has been for sometime and is now procuring electricity under tariffs which include indemnity provisions of the kind now proposed to be included in contracts. The Acting Administrator is concerned that, since the proposed clause contains no limitation on the maximum liability of the Government, he is precluded by law from entering into contracts with these clauses. He is aware of our long line of decisions which hold that, unless otherwise authorized by law, an indemnity provision in a contract which subjects the United States to a contingent and undetermined amount of liability would violate 31 U.S.C. § 665(a) (the Anti-deficiency Act) and 41 U.S.C. § 11 (the Adequacy of Appropriations Act) since it can never be said that sufficient funds have been appropriated to cover such contingencies. See, for example, 7 Comp. Gen. 507 (1928); 16 id. 803 (1937); and 35 id. 85 (1955). See also California-Pacific Utilities Co., v. United States, 114 Ct. Cl. 703, 715-716 (1971).

In 54 Comp. Gen. 824 (1975), we proposed that a clause be inserted in any contract providing for assumption of risk for contractor-owned property which limits the amount of such risk to appropriations available for indemnity payments at the time a loss arises, with no implication that the Congress will be required to appropriate funds to make up for any deficiency. This solution would be unacceptable to the utilities, according to GSA, because there is no real assurance that they would be protected in the event of a large award for personal injury.

As a possible solution, GSA's letter suggests adding the following proviso to the proposed indemnification clause:

> "Provided, however, that nothing herein shall bind or obligate the Government for any liability beyond that for which it would be liable under the Federal Tort Claims Act."

The precise effect of this proviso is unclear. If the intent is to restrict the Government's liability to the liability it would incur even without the indemnification clause, i.e., liability under the Federal Tort Claims Act (FTCA) to the victim of the United States' negligence, then we find it unobjectionable. However, the proviso would not make funds available to indemnify the

utility for payments which it might make to the victim, should the victim choose to seek recovery from the utility instead of from the United States.

The problem cannot be resolved without new legislation if we adopt an overly technical and literal reading of the Anti-deficiency Act in this situation. We do not think such a reading is appropriate under these circumstances. GSA is authorized to procure utility services for the Government and to do so under utilities' tariffs. The procurement of goods or services from State-regulated utilities which are virtually monopolies is unique in important ways. As a practical matter, there is no other source for the needed goods or services. Moreover, the tariff requirements, such as this indemnification undertaking, are applicable generally to all of the same class of customers of the utility, and are included in the tariff only after administrative proceedings in which the Government has the opportunity to participate. The United States is not being singled out for discriminatory treatment nor, presumably, can it complain that the objectionable provision was imposed without notice and the opportunity for a hearing.

Under the circumstances, we have not objected in the past to the procurement of power by GSA under tariffs containing the indemnity clause and there is no reason to object to the purchase of power under contracts containing essentially the same indemnity clause. As noted already, this has of necessity been the practice in the past. The possibility of liability under the clause is in our judgment remote. In any event, we see little purpose to be served by a rule which prevents the United States from procuring a vital commodity under the same restrictions as other customers are subjected to under the tariff if the utility insists that the restrictions are non-negotiable. However, because the possibility exists, however remote, that these agreements could result in future liability in excess of available appropriations, GSA should inform the Congress of the situation.

Harry R. Van Cleve

For the Comptroller General
of the United States

relating to the making, performance, amendment, or modification of contracts, whenever he deems that such action would facilitate the nation defense. The authority conferred by this section shall not be utilized obligate the United States in an amount in excess of $50,000 with approval by an official at or above the level of an Assistant Secretary of Deputy, or an assistant head or his deputy, of such department or agen or by a Contract Adjustment Board established therein. The author conferred by this section may not be utilized to obligate the United Sta in any amount in excess of $25,000,000 unless the Committees on Armed Services of the Senate and the House of Representatives have been notified in writing of such proposed obligation and 60 days of continuous session Congress have expired following the date on which such notice was transmitted to such Committees and neither House of Congress has adopted, within such 60-day period, a resolution disapproving such obligation. For purposes of this section, the continuity of a session of Congress is broken only by an adjournment of the Congress sine die, and the days on which either house is not in session because of an adjournment of more than 3 days to a day certain are excluded in the computation of such 60-day period.

(Aug. 28, 1958, P. L. 85-804, § 1, 72 Stat. 972; Nov. 16, 1973, P. L. 93-155, Title VIII, § 807(a), 87 Stat. 615.)

HISTORY; ANCILLARY LAWS AND DIRECTIVES

Amendments:

1973. Act Nov. 16, 1973, inserted "The authority conferred by this section may not be utilized to obligate the United States in any amount in excess of $25,000,000 unless the Committees on Armed Services of the Senate and the House of Representatives have been notified in writing of such proposed obligation and 60 days of continuous session of Congress have expired following the date on which such notice was transmitted to such Committees and neither House of Congress has adopted, within such 60-day period, a resolution disapproving such obligation. For purposes of this section, the continuity of a session of Congress is broken only by an adjournment of the Congress sine die, and the days on which either house is not in session because of an adjournment of more than 3 days to a day certain are excluded in the computation of such 60-day period.".

Other provisions:

Contracting authority of government agencies in connection with national defense functions. Ex. Or. No. 10789 of Nov. 14, 1958, 23 Fed. Reg. 8897; Ex. Or. No. 11051 of Sept. 28, 1962, 27 Fed. Reg. 9683; Ex. Or. No. 11382 of Nov. 28, 1967, 32 Fed. Reg. 16247; Ex. Or. No. 11610 of July 22, 1971, 36 Fed. Reg. 13755; Ex. Or. No. 12148 of July 20, 1979, 44 Fed. Reg. 43239, provided:

By virtue of the authority vested in me by act of August 28, 1958, 72 Stat. 972 [50 USCS §§ 1431 et seq.], hereinafter called the act, and as President of the United States, and in view of the existing national

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emergency declared by Proclamation No. 2914 of December 16, 1950 [note preceding 50 USCS Appx § 1], and deeming that such action will facilitate the national defense, it is hereby ordered as follows:

Part I—Department of Defense

Under such regulations, which shall be uniform to the extent practicable, as may be prescribed or approved by the Secretary of Defense:

1. The Department of Defense is authorized, within the limits of the amounts appropriated and the contract authorization provided therefor, to enter into contracts and into amendments or modifications of contracts heretofore or hereafter made, and to make advance payments thereon, without regard to the provisions of law relating to the making, performance, amendment, or modification of contracts, whenever, in the judgment of the Secretary of Defense, the Secretary of the Army, the Secretary of the Navy, or the Secretary of the Air Force, or the duly authorized representative of any such Secretary, the national defense will be facilitated thereby.

1A. (a) The limitation in paragraph 1 to amounts appropriated and the contract authorization provided therefor shall not apply to contractual provisions which provide that the United States will hold harmless and indemnify the contractor against any of the claims or losses set forth in subparagraph (b), whether resulting from the negligence or wrongful act or omission of the contractor or otherwise (except as provided in subparagraph (b)(2)). This exception from the limitations of paragraph 1 shall apply only to claims or losses arising out of or resulting from risks that the contract defines as unusually hazardous or nuclear in nature. Such a contractual provision shall be approved in advance by an official at a level not below that of the Secretary of a military department and may require each contractor so indemnified to provide and maintain financial protection of such type and in such amounts as is determined by the approving official to be appropriate under the circumstances. In deciding whether to approve the use of an indemnification provision and in determining the amount of financial protection to be provided and maintained by the indemnified contractor, the appropriate official shall take into account such factors as the availability, cost and terms of private insurance, self-insurance, other proof of financial responsibility and workmen's compensation insurance. Such approval and determination, as required by the preceding two sentences, shall be final.

(b)(1) Subparagraph (a) shall apply to claims (including reasonable expenses of litigation and settlement) or losses, not compensated by insurance or otherwise, of the following types:

(A) Claims by third persons, including employees of the contractor, for death, personal injury, or loss of, damage to, or loss of use of property;

(B) Loss of, damage to, or loss of use of property of the contractor;

(C) Loss of, damage to, or loss of use of property of the Government;

(D) Claims arising (i) from indemnification agreements between the contractor and a subcontractor or subcontractors, or (ii) from

such arrangements and further indemnification arrangements between subcontractors at any tier, provided that all such arrangements were entered into pursuant to regulations prescribed or approved by the Secretaries of Defense, the Army, the Navy, or the Air Force.

(2) Indemnification and hold harmless agreements entered into pursuant to this subsection, whether between the United States and a contractor, or between a contractor and a subcontractor, or between two subcontractors, shall not cover claims or losses caused by the willful misconduct or lack of good faith on the part of any of the contractor's or subcontractor's directors or officers or principal officials which are (i) claims by the United States (other than those arising through subrogation) against the contractor or subcontractor, or (ii) losses affecting the property of such contractor or subcontractor. Regulations to be prescribed or approved by the Secretaries of Defense, the Army, the Navy or the Air Force shall define the scope of the term "principal officials".

(3) The United States may discharge its obligation under a provision authorized by subparagraph (a) by making payments directly to subcontractors or to third persons to whom a contractor or subcontractor may be liable.

(c) A contractual provision made under subparagraph (a) that provides for indemnification must also provide for—

(1) notice to the United States of any claim or action against, or of any loss by, the contractor or subcontractor which is covered by such contractual provision; and

(2) control or assistance by the United States, at its election, in the settlement or defense of any such claim or action.

2. The Secretaries of Defense, the Army, the Navy, and the Air Force, respectively, may exercise the authority herein conferred and, in their discretion and by their direction, may delegate such authority to any other military or civilian officers or officials of their respective departments, and may confer upon any such military or civilian officers or officials the power to make further delegations of such authority within their respective commands or organizations: Provided, that the authority herein conferred shall not be utilized to obligate the United States in an amount in excess of $50,000 without approval by an official at or above the level of an Assistant Secretary or his Deputy, or by a departmental Contract Adjustment Board.

3. The contracts hereby authorized to be made shall include agreements of all kinds (whether in the form of letters of intent, purchase orders, or otherwise) for all types and kinds of property or services necessary, appropriate, or convenient for the national defense, or for the invention, development, or production of, or research concerning, any such property or services, including, but not limited to, aircraft, missiles, buildings, vessels, arms, armament, equipment or supplies of any kind, or any portion thereof, including plans, spare parts and equipment therefor, materials, supplies, facilities, utilities, machinery, machine tools, and any other equipment without any restriction of any kind as to type, character, location, or form.

4. The Department of Defense may by agreement modify or amend or settle claims under contracts heretofore or hereafter made, may make advance payments upon such contracts of any portion of the contract price, and may enter into agreements with contractors or obligors modifying or releasing accrued obligations of any sort, including accrued liquidated damages or liability under surety or other bonds. Amendments or modifications of contracts may be with or without consideration and may be utilized to accomplish the same things as any original contract could have accomplished hereunder, irrespective of the time or circumstances of the making, or the form, of the contract amended or modified, or of the amending or modifying contract, and irrespective of rights which may have accrued under the contract or the amendments or modifications thereof.

5. Proper records of all actions taken under the authority of the act shall be maintained within the Department of Defense. The Secretaries of Defense, the Army, the Navy, and the Air Force shall make such records available for public inspection except to the extent that they, or their duly authorized representatives, may respectively deem the disclosure of information therein to be detrimental to the national security.

6. The Department of Defense shall, by March 15 of each year, report to the Congress all actions taken within that department under the authority of the act during the preceding calendar year. With respect to actions which involve actual or potential cost to the United States in excess of $50,000, the report shall (except as the disclosure of such information may be deemed to be detrimental to the national security)—

(a) name the contractor;

(b) state the actual cost or estimated potential cost involved;

(c) describe the property or services involved; and

(d) state further the circumstances justifying the action taken.

7. There shall be no discrimination in any act performed hereunder against any person on the ground of race, religion, color, or national origin, and all contracts entered into, amended, or modified hereunder shall contain such nondiscrimination provision as otherwise may be required by statute or Executive order.

8. No claim against the United States arising under any purchase or contract made under the authority of the act and this order shall be assigned except in accordance with the Assignment of Claims Act of 1940 (54 Stat. 1029), as amended [31 USCS § 203; 41 USCS § 15].

9. Advance payments shall be made hereunder only upon obtaining adequate security.

10. Every contract entered into, amended, or modified pursuant to this order shall contain a warranty by the contractor in substantially the following terms:

"The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, except bona-fide employees or bona-fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty

the Government shall have the right to annul this contract without liability or, in its discretion, to deduct from the contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee."

11. Except as provided in the Act of September 27, 1966, 80 Stat. 850 contracts entered into, amended, or modified pursuant to authority of this order shall include a clause to the effect that the Comptroller General of the United States or any of his duly authorized representatives shall, until the expiration of three years after final payment, have access to and the right to examine any directly pertinent books, documents, papers, and records of the contractor or any of his subcontractors engaged in the performance of, and involving transactions related to, such contracts or subcontracts. Before exercising the authority provided in the Act of September 27, 1966, 80 Stat. 850, the Secretaries of Defense, the Army, the Navy, or the Air Force, or their designees, shall first determine that all reasonable efforts have been made to include the clause prescribed above and that alternate sources of supply are not reasonably available.

12. Nothing herein contained shall be construed to constitute authorization hereunder for—

(a) the use of the cost-plus-a-percentage-of-cost system of contracting;

(b) any contract in violation of existing law relating to limitation of profits or fees;

(c) the negotiation of purchases of or contracts for property or services required by law to be procured by formal advertising and competitive bidding;

(d) the waiver of any bid, payment, performance, or other bond required by law;

(e) the amendment of a contract negotiated under section 2304(a)(15) of title 10 of the United States Code [10 USCS § 2304(a)(15)] to increase the contract price to an amount higher than the lowest rejected bid of any responsible bidder; or

(f) the formalization of an informal commitment, unless the Secretary of Defense, the Secretary of the Army, the Secretary of the Navy, or the Secretary of the Air Force, or the duly authorized representative of any such Secretary, finds that at the time the commitment was made it was impracticable to use normal procurement procedures.

13. The provisions of the Walsh-Healey Act (49 Stat. 2036), as amended [41 USCS §§ 35 et seq.], the Davis-Bacon Act (49 Stat. 1011), as amended [40 USCS §§ 276a et seq.], the Copeland Act (48 Stat. 948), as amended [now 18 USCS § 874], and the Eight Hour Law (37 Stat. 137), as amended, if otherwise applicable, shall apply to contracts made and performed under the authority of this order.

14. Nothing herein contained shall prejudice anything heretofore done under Executive Order No. 9001 of December 27, 1941, or Executive Order No. 10210 of February 2, 1951, or any amendments or extensions thereof, or the continuance in force of an action heretofore taken under those orders or any amendments or extensions thereof.

15. Nothing herein contained shall prejudice any other authority which the Department of Defense may have to enter into, amend, or modify contracts, and to make advance payments.

Part II—Extension of Provisions of Paragraphs 1-14

21. Subject to the limitations and regulations contained in paragraphs 1 to 14, inclusive, hereof, and under any regulations prescribed by him in pursuance of the provisions of paragraph 22 hereof, the head of each of the following-named agencies is authorized to perform or exercise as to his agency, independently of any Secretary referred to in the said paragraphs 1 to 14, all the functions and authority vested by those paragraphs in the Secretaries mentioned therein:

Department of the Treasury
Department of the Interior
Department of Agriculture
Department of Commerce
Department of Transportation
Atomic Energy Commission
General Services Administration
National Aeronautics and Space Administration
Tennessee Valley Authority
Government Printing Office
The Federal Emergency Management Agency

22. The head of each agency named in paragraph 21 hereof is authorized to prescribe regulations governing the carrying out of the functions and authority vested with respect to his agency by the provisions of paragraph 21 hereof. Such regulations shall, to the extent practicable, be uniform with the regulations prescribed or approved by the Secretary of Defense under the provisions of Part I of this order.

23. Nothing contained herein shall prejudice any other authority which any agency named in paragraph 21 hereof may have to enter into, amend, or modify contracts and to make advance payments.

24. Nothing contained in this Part shall constitute authorization thereunder for the amendment of a contract negotiated under section 302(c)(14) of the Federal Property and Administrative Services Act of 1949 (63 Stat. 394), as amended by section 2(b) of the act of August 28, 1958, 72 Stat. 966 [41 USCS § 252(c)(14)], to increase the contract price to an amount higher than the lowest rejected bid of any responsible bidder

Contracts, loans, guarantees, commitments, or other obligations entered into prior to November 16, 1973. Act Nov. 16, 1973, P. L. 93-155, Title VIII, § 807(e), 87 Stat. 616, provided that the amendments made to this section "shall not affect the carrying out of any contract, loan, guarantee, commitment, or other obligation entered into prior to the date of enactment of this section [enacted Nov. 16, 1973].".

RESEARCH GUIDE

Am Jur Trials:

Representing the Government Contractor, 14 Am Jur Trials, p. 437.

Law Review Articles:

Jansen, Public Law 85-804 and Extraordinary Contractual Relief, 55 Georgetown L J 959 (1967).

Office of the
Assistant Attorney General

Washington, D.C. 20530

Mr. William S. Coleman, Jr.
Deputy Associate Administrator for
Procurement Law and Legislation
Task Group Co-Chairman
Office of Management and Budget
Washington, D. C. 20503

Dear Mr. Coleman:

This responds to your letter of September 8, 1981, relating to indemnification of government contractors for liability arising from government programs.

You note that an amendment is being considered to Executive Order No. 10789, "Contracting Authority of Government Agencies in Connection with National Defense Functions." At present this Executive order permits designated agencies to enter contracts that provide that the United States will hold harmless and indemnify the contractor against claims "arising out of or resulting from risks that the contract defines as unusually hazardous or nuclear in nature." E.O. No. 10789, ¶ 1A. We understand that some agencies do not take advantage of the present authority because, for a variety of reasons, they do not want to define their activities as being "unusually hazardous." A group studying the matter has therefore proposed that indemnity contracts also be authorized for activities "giving rise to the possibility of catastrophic losses." You ask whether there is legal authority for such an amendment.

The Executive order is authorized by Section 1431 of Title 50 of the United States Code, 72 Stat. 972 (1958). This provision is very broad. It states that the President may authorize any department or agency which exercises national defense functions to enter into contracts "without regard to other provisions of law . . . whenever he deems that this action would facilitate the national defense." The legislative history of this section shows that Congre fully realized that it would enable the President to permit the

Enclosure 1

conclusion of indemnity agreements under which the United States would assume financial responsibility for catastrophic incidents with very high potential liabilities. */ A wide range of activities involved the possible risk of catastrophe such as construction of missiles, satellites, ships and submarines. E.g., 104 Cong. Rec. 15469 (Rep. Forrester). Because of the magnitude of the risks involved, commercial insurance policies were not available to provide sufficient coverage. Contractors were therefore reluctant to enter into contracts involving the risk of a catastrophe without an indemnification provision. H.R. Rep. No. 2232, 85th Cong. 2d Sess. 6 (1958).

Neither the statute nor its legislative history demands the use of any particular language in the Executive order as long as it is used to carry out the purposes of the law--to facilitate the national defense. The use of this legislation to insure against "catastrophic loss" seems, on its face, to be within the authority granted. Questions may arise as to whether particular cases fall under the order and we do not pass on those here. We conclude therefore that the President has the power to make the proposed change in the Executive order.

Sincerely,

Theodore B. Olson

Theodore B. Olson
Assistant Attorney General
Office of Legal Counsel

*/ The legislative history of 50 U.S.C. § 1431 and the power to conclude indemnity contracts are reviewed in detail in a memorandum of the Office of Legal Counsel captioned "Statutory authority of Defense agencies to indemnify their contractors against uninsurable risks," August 11, 1967, transmitted by Acting Assistant Attorney General Richman to the Acting General Counsel of the Department of Defense.

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THE UNITED STATES GOVERNMENT MANUAL 1981/82

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EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

OFFICE OF FEDERAL PROCUREMENT POLICY

FEB 20 1982

Envelope addressed to Mr. Beggs

MEMORANDUM FOR THE HEADS OF EXECUTIVE AGENCIES AND ESTABLISHMENTS

SUBJECT: Indemnification of Government Contractors for Risk of Catastrophic Accidents Resulting from Activities Under Government Contracts -- Request for Comments

An Interagency Task Force, co-sponsored by this office and NASA, has reviewed the question of providing indemnification to Government contractors and recommended an amendment to Executive Order 10789.

You are requested to review the attached report and draft Executive order and provide your agency's views to this office not later than March 1, 1982. This limited review period is necessitated by the need to support space shuttle activities.

Donald E. Sowle
Administrator

Enclosures: - not retained in AEM
Task Force Report, dated January 28, 1982
Draft Amended Executive Order 10789

CONTRACTING AUTHORITY OF GOVERNMENT AGENCIES IN CONNECTION WITH NATIONAL DEFENSE FUNCTIONS

By virtue of the authority vested in me by the act of August 28, 1958, 72 Stat. 972, hereinafter called the act, and as President of the United States, and in view of the existing national emergency declared by Proclamation No. 2914 of December 16, 1950, and deeming that such action will facilitate the national defense, it is hereby ordered as follows:

PART I - DEPARTMENT OF DEFENSE

Under such regulations, which shall be uniform to the extent practicable, as may be prescribed or approved by the Secretary of Defense:

1. The Department of Defense is authorized, within the limits of the amounts appropriated and the contract authorization provided therefor, to enter into contracts and into amendments or modifications of contracts heretofore or hereafter made, and to make advance payments thereon, without regard to the provisions of law relating to the making, performance, amendment, or modification of contracts, whenever, in the judgment of the Secretary of Defense, the Secretary of the Army, the Secretary of the Navy, or the Secretary of the Air Force, or the duly authorized representative of any such Secretary, the national defense will be facilitated thereby.

1A. (a) The limitation in paragraph 1 to amounts appropriated and the contract authorization provided therefor shall not apply to contractual provisions which provide that the United States will hold harmless and indemnify the contractor against any of the claims or losses set forth in subparagraph (b), whether resulting from the negligence or wrongful act or omission of the contractor or otherwise (except as provided in subparagraph (b)(2)). This exception from the limitations of paragraph 1 shall apply only to claims or losses arising out of (1) unusually hazardous or nuclear in nature or (2) giving rise to the possibility of catastrophic losses; i.e., losses which the particular contractor cannot reasonably protect against through private insurance or self-insurance by the payment of a reasonable premium or the establishment of or reliance on a reasonable self-insurance reserve. Such a contractual provision shall be approved in advance by an official at a level not below that of the Secretary of a military department and may require each contractor so indemnified to provide and maintain financial protection of such type and in such amounts as is determined by the approving official to be appropriate under the circumstances. In deciding whether to approve the use of an indemnification provision and in determining the amount of financial protection to be provided and maintained by the indemnified contractor, the appropriate official shall take into account such factors as the availability, cost and terms of private insurance, self-insurance, other proof of financial responsibility and workmen's compensation insurance. Such approval and determination, as required by the preceding two sentences, shall be final.

(b) (1) Subparagraph (a) shall apply to claims (including reasonable expenses of litigation and settlement) or losses, not compensated by insurance or otherwise, of the following types:

(A) Claims by third persons, including employees of the contractor, for death, personal injury, or loss of, damage to, or loss of use of property;

(B) Loss of, damage to, or loss of use of property of the contractor;

(C) Loss of, damage to, or loss of use of property of the Government;

(D) Claims arising (i) from indemnification agreements between the contractor and a subcontractor or subcontractors, or (ii) from such arrangements and further indemnification arrangements between subcontractors at any tier; provided that all such arrangements were entered into pursuant to regulations prescribed or approved by the Secretaries of Defense, the Army, the Navy, or the Air Force.

(2) Indemnification and hold harmless agreements entered into pursuant to this subsection, whether between the United States and a contractor, or between a contractor and a subcontractor, or between two subcontractors, shall not cover claims or losses caused by the willful misconduct or lack of good faith on the part of any of the contractor's or subcontractor's directors or officers or principal officials which are (i) claims by the United States (other than those arising through subrogation) against the contractor or subcontractor, or (ii) losses

affecting the property of such contractor or subcontractor. Regulations to be prescribed or approved by the Secretaries of Defense, the Army, the Navy or the Air Force shall define the scope of the term "principal officials".

(3) The United States may discharge its obligation under a provision authorized by subparagraph (a) by making payments directly to subcontractors or to third persons to whom a contractor or subcontractor may be liable.

(c) A contractual provision made under subparagraph (a) that provides for indemnification must also provide for --

(1) notice to the United States of any claim or action against, or of any loss by, the contractor or subcontractor which is covered by such contractual provision; and

(2) control or assistance by the United States, at its election, in the settlement or defense of any such claim or action.

2. The Secretaries of Defense, the Army, the Navy, and the Air Force, respectively, may exercise the authority herein conferred and, in their discretion and by their direction, may delegate such authority to any other military or civilian officers or officials of their respective departments, and may confer upon any such military or civilian officers or officials the power to make further delegations of such authority within their respective commands or organizations: Provided, that the authority herein conferred shall not be utilized to obligate the United States in

an amount in excess of $50,000 without approval by an official at or above the level of an Assistant Secretary or his Deputy, or by a departmental Contract Adjustment Board.

3. The contracts hereby authorized to be made shall include agreements of all kinds (whether in the form of letters of intent, purchase orders, or otherwise) for all types and kinds of property or services necessary, appropriate, or convenient for the national defense, or for the invention, development, or production of, or research concerning, any such property or services, including, but not limited to, aircraft, missiles, buildings, vessels, arms, armament, equipment or supplies of any kind, or any portion thereof, including plans, spare parts and equipment therefor, materials, supplies, facilities, utilities, machinery machine tools, and any other equipment without any restriction of any kind as to type, character, location, or form.

4. The Department of Defense may by agreement modify or amend or settle claims under contracts heretofore or hereafter made, may make advance payments upon such contracts of any portion of the contract price, and may enter into agreements with contractors or obligors modifying or releasing accrued obligations of any sort, including accrued liquidated damages or liability under surety or other bonds. Amendments or modifications of contracts may be with or without consideration and may be utilized to accomplish the same things as any original contract could have accomplished hereunder, irrespective of the time or circumstances of the making, or the form, of the contract amended or modified, or of the amending or modifying contract, and irrespective of rights which may have accrued under the contract or the amendments or modifications thereof.

5. Proper records of all actions taken under the authority of the act shall be maintained within the Department of Defense. The Secretaries of Defense, the Army, the Navy, and the Air Force shall make such records available for public inspection except to the extent that they, or their duly authorized representatives, may respectively deem the disclosure of information therein to be detrimental to the national security.

6. The Department of Defense shall, by March 15 of each year, report to the Congress all actions taken within that department under the authority of the act during the preceding calendar year. With respect to actions which involve actual or potential cost to the United States in excess of $50,000, the report shall (except as the disclosure of such information may be deemed to be detrimental to the national security) --

(a) name the contractor;

(b) state the actual cost or estimated potential cost involved;

(c) describe the property or services involved; and

(d) state further circumstances justifying the action taken.

7. There shall be no discrimination in any act performed hereunder against any person on the ground of race, religion, color or national origin, and all contracts entered into, amended, or modified hereunder shall contain such non-

discrimination provision as otherwise may be required by statute or Executive order.

8. No claim against the United States arising under any purchase or contract made under the authority of the act and this order shall be assigned except in accordance with the Assignment of Claims Act of 1940 (54 Stat. 1029), as amended [section 203 of Title 31 and section 15 of Title 41].

9. Advance payments shall be made hereunder only upon obtaining adequate security.

10. Every contract entered into, amended, or modified pursuant to this order shall contain a warranty by the contractor in substantially the following terms:

"The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, except bona-fide employees or bona-fide established commercial or selling agencies maintained by the contractor for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or, in its discretion, to deduct from the contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee."

11. Except as provided in the Act of September 27, 1966, 80 Stats. 850 [which amended section 1433 of this title, sections 2310, 2313 of Title, Armed Forces, and section 254 of Title 41, Public Contracts] contracts entered into, amended, or modified pursuant to authority of this order shall include a clause to the effect that the Comptroller General of the United States or any of his duly authorized representatives shall, until the expiration of three years after final payment, have access to and the right to examine any directly pertinent books, documents, papers, and records of the contractor or any of his subcontractors engaged in the performance of, and involving transactions related to, such contracts or subcontracts. Before exercising the authority provided in the Act of September 27, 1966, 80 Stat. 850 [which amended section 1433 of this title, sections 2310, 2313 of Title 10, Armed Forces, and section 254 of Title 41, Public Contracts], the Secretaries of Defense, the Army, the Navy or the Air Force, or their designees, shall first determine that all reasonable efforts have been made to include the clause prescribed above and that alternate sources of supply are not reasonably available.

12. Nothing herein contained shall be construed to constitute authorization hereunder for --

(a) the use of the cost-plus-a-percentage-of-cost system of contracting;

(b) any contract in violation of existing law relating to limitation of profits or fees;

(c) the negotiation of purchases of or contracts for property or services required by law to be procured by formal advertising and competitive bidding;

(d) the waiver of any bid, payment, performance, or other bond required by law;

(e) the amendment of a contract negotiated under section 2304((a)(15) of title 10 of the United States Code to increase the contract price to an amount higher than the lowest rejected bid of any responsible bidder; or

(f) the formalization of an informal commitment, unless the Secretary of Defense, the Secretary of the Army, the Secretary of the Navy, or the Secretary of the Air Force, or the duly authorized representative of any such Secretary, finds that at the time the commitment was made it was impracticable to use normal procurement procedures.

13. The provisions of the Walsh-Healey Act (49 Stat. 2036) as amended [sections 35-45 of Title 41], the Davis-Bacon Act (49 Stat. 1011), as amended [sections 276a to 276a-5 of Title 40], the Copeland Act (48 Stat. 948), as amended, and the Eight-Hour Law (37 Stat. 137, as amended [sections 321 and 322 of Title 40], if otherwise applicable, shall apply to contracts made and performed under the authority of this order.

14. Nothing herein contained shall prejudice anything heretofore done under Executive Order No. 9001 of December 27, 1941, or Executive Order No. 10210 of

February 2, 1951 [set out as notes under section 611 of this Appendix to this title], or any amendments or extensions thereof, or the continuance in force of an action heretofore taken under those orders or any amendments or extensions thereof.

15. Nothing herein contained shall prejudice any other authority which the Department of Defense may have to enter into, amend, or modify contracts, and to make advance payments.

PART II - EXTENSION OF PROVISIONS OF PARAGRAPHS 1-14

21A. Subject to the limitations and regulations contained in paragraphs 1 to 14, inclusive, hereof, and under any regulations prescribed by him in pursuance of the provisions of paragraph 22 hereof, the head of each of the following named agencies is authorized to perform or exercise as to his agency, independently of any Secretary referred to in the said paragraphs 1 to 14, all the functions and authority vested by those paragraphs in the Secretaries mentioned therein:

Department of the Treasury

Department of the Interior

Department of Agriculture

Department of Commerce

Department of Transportation

Atomic Energy Commission

General Services Administration

National Aeronautics and Space Administration

Tennessee Valley Authority

Government Printing Office

The Federal Emergency Management Agency

21B. Subject to the limitations and regulations contained in paragraphs 1 to 14, inclusive, hereof, and under any regulations prescribed by him in pursuance of the provisions of paragraph 22 hereof, the head of each of the following-identified agencies is authorized to perform or exercise as to his agency, independently of any Secretary referred to in the said paragraphs 1 to 14, the authority described in paragraphs 1 and 1A hereof to provide in a contract provision that the United States will hold harmless and indemnify the contractor against specified claims or losses as set forth therein:

Each Executive Agency of the United States as defined in 5 U.S.C. 105.

22. The head of each agency named or identified in paragraph 21 hereof is authorized to prescribe regulations governing the carrying out of the functions and authority vested with respect to his agency by the provisions of paragraph 21 hereof. Such regulations shall, to the extent practicable, be uniform with the regulations prescribed or approved by the Secretary of Defense under the provisions of Part I of this order.

23. Nothing contained herein shall prejudice any other authority which any agency named or identified in paragraph 21 hereof may have to enter into, amend, or modify contracts and to make advance payments.

24. Nothing contained in this Part shall constitute authorization thereunder for the amendment of a contract negotiated under section 302(c) (14) of the Federal Property and Administrative Services Act of 1949 (63 Stat. 394), as amended by section 2(b) of the act of August 28, 1958, 72 Stat. 966 [section 252(c)(14) of Title 41], to increase the contract price to an amount higher than the lowest rejected bid of any responsible bidder.

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

FEB 6 1982

Mr. Edwin Harper
Deputy Director
Office of Management and Budget
Old Executive Office Building
17th Street and Pennsylvania Avenue, NW
Washington, DC 20500

Dear Ed:

My General Counsel, S. Neil Hosenball, has advised me that the OFPP Interagency Task Force on Indemnification has voted to recommend a change in Executive Order 10789. I understand that this recommendation has been forwarded to Mr. Donald Sowle, the Administrator for the Office of Federal Procurement Policy.

I strongly recommend that your office take quick action to implement the recommended changes to Executive order 10789. In particular, the amendment which would authorize NASA and other agencies to agree to indemnify a contractor if the contract gives rise to the possibility of catastrophic losses is of great importance to NASA. Heretofore, we have been unable to agree to indemnify our contractors because of our inability to determine that our contractors' work was unusually hazardous or nuclear in nature--the current condition in Executive order 10789.

We believe the amendment to be in the best interest of this country and quick action is recommended since NASA contractors and subcontractors are currently being denied coverage for their Shuttle contract work under their general product liability policies; I understand that a separate policy, no doubt expensive, will have to be obtained by them for their Shuttle oriented work, assuming that the insurance industry will be willing to provide such coverage. In addition, there is the danger that many small contractors will withdraw from the program if insurance becomes too expensive or unavailable. The costs of such a policy will be passed on to NASA. These funds could be put to better use to accomplish NASA's mission and as you know are badly needed for this purpose.

I would appreciate your help.

Sincerely,

James M. Beggs
Administrator

Ed -
who else do we need this over
to?

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

FEB 6 1982

Honorable William French Smith
Attorney General of the United States
Department of Justice
10th Street and Constitution Avenue, NW
Washington, DC 20530

Dear Mr. Smith:

My General Counsel, S. Neil Hosenball, has advised me that the OFPP Interagency Task Force on Indemnification has voted to recommend a change in Executive order 10789. There is, I understand, one dissent to the recommendation; Mr. Jeffrey Axelrad, Department of Justice, has indicated that he will dissent for the reasons to be provided in writing in the near future. His dissent is based on his personal analysis, I understand, and as the Task Force's report indicates, this dissent does not necessarily represent the views of the Department of Justice.

I ask that the Department of Justice support the recommended changes to Executive order 10789. Of great importance to NASA is the proposed amendment which would authorize NASA and other agencies to agree to indemnify a contractor if a contract gives rise to the possibility of catastrophic losses. As indicated in the enclosed letter of October 28, 1981, to Mr. Coleman from Mr. Theodore B. Olson, Assistant Attorney General, Office of Legal Counsel, this proposed amendment ". . .seems, on its face, to be within the [legislative] authority granted." Heretofore, NASA has been unable to agree to indemnify our contractors because of our inability to determine that our contractors' work was unusually hazardous or nuclear in nature--the current condition in Executive order 10789.

We believe the amendment to be in the best interest of this country. Currently, NASA contractors and subcontractors are being denied coverage for their Shuttle contract work under their general product liability policies. I understand that a separate policy, no doubt expensive, will have to be obtained by them for their Shuttle oriented work, assuming that the insurance industry will be willing to provide such coverage. The costs of such a policy will be passed on to NASA. These funds could be put to better use to accomplish NASA's mission and we are desperate to keep such indirect expenses to our program to a minimum.

Neil Hosenball will be glad to meet with you or members of your staff if you feel such a meeting would be necessary or useful.

I would appreciate your help.

Sincerely,

James M. Beggs
Administrator

Enclosure

Rec'd from:
Jeff Gallant
3/2/82

26 FEB 1982

Mr. Donald E. Sowle
Administrator for Federal
Procurement Policy
New Executive Office Bldg.
726 Jackson Place, N.W.
Washington, D.C. 20503

Dear Mr. Sowle:

This responds on behalf of the Department of Justice to your memorandum of February 20, 1982 seeking our views with regard to the Report of the OFPP Interagency Task Force on Indemnification, Part I, Indemnification of Government Contractors Against Third Party Liability Claims.

I have carefully reviewed the Report and the dissenting statement. The dissenting statement recites compelling reasons why the proposed modifications in Executive Order 10789 are unsound and should not be enacted. Accordingly, the Department of Justice is of the opinion that your Office should adopt the views set forth in the dissenting statement.

Very truly yours,

J. PAUL McGRATH
Assistant Attorney General
Civil Division

MAR 8 1982

Honorable William French Smith
Attorney General of the United States
Department of Justice
10th Street and Constitution Avenue, NW
Washington, DC 20530

Re: Indemnification of Government Contractors Against Third-Party Liability Claims (Proposed Amendment to Executive Order 10789)

Dear Mr. Smith:

I ask that you personally review and reconsider the position taken by the Department of Justice in the enclosed letter by Mr. J. Paul McGrath, Assistant Attorney General, Civil Division, dated February 26, 1982, to the Administrator for Federal Procurement Policy.

In my letter to you dated February 6, 1982, a copy of which is enclosed, I had asked for your support to certain recommended changes to Executive Order 10789. These changes would have permitted NASA to indemnify the Space Shuttle contractors if the contract gave rise to the possibility of catastrophic losses. The Department of Justice position which is provided in the enclosed letter from Mr. McGrath dated February 26, 1982, did not take into account, I understand, my letter of February 6, 1982, to you.

I would like to re-emphasize the importance of this indemnity authority to NASA and ask again that you consider supporting the proposed amendments to the Executive Order proposed by the Administrator for Federal Procurement Policy.

We would be happy to meet with you or your representatives to explain our position.

Sincerely,

Original Signed by
James M. Beggs

James M. Beggs
Administrator

Enclosures

bcc:
A, AD, ADB, AEM-2, G, H, O
prep: GK-3/RJWojtal:vtr:53169:3/3/82

CONCURRENCE:
G/Hosenball

MAR 9 1982

(82-32008)

Mr. Donald E. Sowle
Administrator for Federal
Procurement Policy
Executive Office of the President
Office of Management and Budget
Washington, DC 20503

Re: Indemnification of Government Contractors Against Third-Party Liability Claims (Proposed Amendment to Executive Order 10789)

Dear Mr. Sowle:

As you know, NASA has sought to obtain authority to indemnify its contractors where NASA contracts may give rise to the possibility of catastrophic losses. We were hopeful that this authority could be obtained through a study by a Task Force on Indemnification sponsored by OFPP, which studied the issue of indemnification as it relates to all Government contractors.

Although the Task Force recommended on January 28, 1982, an amendment to Executive Order 10789 which amendment NASA supported, and which would have been applicable to all Federal Executive Agencies and Military Departments, the Department of Justice has objected to this amendment and I understand other Government agencies may object to the amendment for various reasons. The proposed amendment, I believe, will not be adopted promptly because of these objections.

Because I believe that it is essential to the accomplishment of NASA's mission that it have promptly the authority to indemnify its contractors involved in space activities (which activities are not unusually hazardous), I request that you support an amendment to E.O. 10789 which would affect primarily NASA. I propose that Part I, paragraph 1.A(a), second sentence of that Executive Order be revised by adding the following underscored language:

> "This exception from the limitations of paragraph 1 shall apply only to claims or losses arising out of or resulting from risks that the contract defines as unusually hazardous or nuclear in nature or space activities." (Underscoring added)

This underscored language is based upon the definition of the term "national defense" in the Defense Production Act of 1950, 50 U.S.C. App. 2061-2069. At 50 U.S.C. App. 2152(d) the Act states:

> "The term 'national defense' means programs for military and atomic energy production or construction, military assistance to any foreign nation, stockpiling, space, and directly related activity."

By so amending E.O. 10789, NASA would have the authority it needs to indemnify its contractors who are involved, for example, in the design, manufacture, assembly, or integration of spacecraft, space vehicles and their components as well as the authority to indemnify its contractors who provide NASA with support services related to space activities.

We would appreciate your help in obtaining this proposed amendment to E.O. 10789. Please call me at 755-3875 if you have any questions on the proposal or if I may assist you in obtaining the proposed amendment.

Sincerely,

S. Neil Hosenball
General Counsel

cc:
Jeffrey Axelrad
Department of Justice

MAR 9 1982

G(82-32009)

Mr. J. Paul McGrath
Assistant Attorney General
Civil Division
Department of Justice
Washington, DC 20530

Re: Indemnification of Government Contractors Against Third-Party Liability Claims (Proposed Amendment to Executive Order 10789)

Dear Mr. McGrath:

Enclosed for your information is a letter dated March 8, 1982, from the NASA Administrator to the Attorney General, requesting that he reconsider the position taken by you, on behalf of the Department of Justice, in your letter of February 26, 1982, to the Administrator for Federal Procurement Policy, on the above subject.

In addition, in order to meet NASA's immediate indemnification needs, in the enclosed letter of March 9, 1982, I have asked the Administrator for Federal Procurement Policy to consider supporting an alternative amendment to Executive Order 10789 that is described in the letter. This alternative amendment is extremely narrow in its application and would continue unchanged the preconditions to other Government agencies' exercise of the indemnification authority provided by Executive Order 10789 unless the agency is involved in space activities. This alternative amendment would permit NASA to indemnify its contractors to the extent involved in space activities without determining that the contractor is involved in unusually hazardous activities.

We hope that this extremely limited proposed amendment which NASA needs will not be objected to by the Department of

Justice. I am available to discuss the proposed amendment with you to answer any questions you may have. Please call me at 755-3875.

Sincerely,

S. Neil Hosenball
General Counsel

S. Neil Hosenball
General counsel

Enclosures

cc:
Jeffrey Axelrad
Department of Justice

MAR 9 1982

G(82-32009)

Mr. J. Paul McGrath
Assistant Attorney General
Civil Division
Department of Justice
Washington, DC 20530

Re: Indemnification of Government Contractors Against Third-Party Liability Claims (Proposed Amendment to Executive Order 10789)

Dear Mr. McGrath:

Enclosed for your information is a letter dated March 8, 1982, from the NASA Administrator to the Attorney General, requesting that he reconsider the position taken by you, on behalf of the Department of Justice, in your letter of February 26, 1982, to the Administrator for Federal Procurement Policy, on the above subject.

In addition, in order to meet NASA's immediate indemnification needs, in the enclosed letter of March 9, 1982, I have asked the Administrator for Federal Procurement Policy to consider supporting an alternative amendment to Executive Order 10789 that is described in the letter. This alternative amendment is extremely narrow in its application and would continue unchanged the preconditions to other Government agencies' exercise of the indemnification authority provided by Executive Order 10789 unless the agency is involved in space activities. This alternative amendment would permit NASA to indemnify its contractors to the extent involved in space activities without determining that the contractor is involved in unusually hazardous activities.

We hope that this extremely limited proposed amendment which NASA needs will not be objected to by the Department of

Justice. I am available to discuss the proposed amendment with you to answer any questions you may have. Please call me at 755-3875.

Sincerely,

S. Neil Hosenball
General Counsel

S. Neil Hosenball
General counsel

Enclosures

cc:
Jeffrey Axelrad
Department of Justice

U.S. Department of Justice
Civil Division

Office of the Assistant Attorney General

Washington, D.C. 20530

June 11, 1982

S. Neil Hosenball, Esq.
General Counsel
National Aeronautics and Space
Administration
400 Maryland Avenue, S.W.
Washington, D.C. 20546

Dear Neil:

Attached is a copy of my letter to Donald E. Sowle concerning proposed amendments to Executive Order 10789. As we discussed, I amended the language in line seven of paragraph two of my earlier draft from "it will be impossible" to "there is a substantial risk that NASA would be unable".

I hope that this satisfactorily resolves the matter from both of our points of view.

Sincerely,

J. Paul McGrath
Assistant Attorney General

Attachment

Civil Division

Office of the Assistant Attorney General

Washington, D.C. 20530

June 11, 1982

Mr. Donald E. Sowle
Administrator for
Federal Procurement and Policy
Office of Management and Budget
Washington, D.C. 20503

Dear Mr. Sowle:

On March 26, 1982, I advised you that the Department of Justice opposes proposed amendments to Executive Order 10789 suggested by the OFPP Interagency Task Force on Indemnification in Part I of its report entitled Indemnification of Government Contractors Against Third Party Liability Claims. While I reiterate our opposition to the proposals included in the Task Force report, I have recently reviewed the more narrow proposal suggested in the letter of S. Neil Hosenball, General Counsel of the National Aeronautics and Space Administration, to you, dated March 9, 1982. NASA's proposal is to add "space activities" to the matters within the purview of the Executive Order.

I have considered the proposed amendment to Executive Order 10789 which NASA proposes in Mr. Hosenball's March 9, 1982 letter. The Department of Justice objects to the proposal but would not maintain its objection if NASA is of the view, and OMB verifies, that NASA cannot enter into contracts for essential space activities without the expanded authority NASA proposes. In other words, were NASA to determine (and OMB verify) that there is a substantial risk that NASA would be unable to obtain the necessary participation of private contractors in essential space activities without this additional authority (as contrasted with causing increased direct costs to NASA), the Department of Justice would not continue to oppose the modification. Any such modification should be in lieu of the Task Force proposal.

In order to confine extraordinary procurement authority as narrowly as possible, reconsideration of the desirability of any amendment of the Executive Order may be warranted.

Based upon our review of the issues, I suggest that you give serious consideration to the availability of alternative means of fulfilling NASA's responsibilities.

Yours very truly,

J. PAUL MCGRATH
Assistant Attorney General

cc: S. Neil Hosenball, Esq.

Shuttle Orbiter Division
Rockwell International Corporation
12214 Lakewood Boulevard
Downey, California 90241

Rockwell International

Tom Newman -
Per our discussion.
Bob Hallbrook
John Stu Evans
cc

July 7, 1982

In Reply Refer to 82MA3601

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

Attention: R. E. Easley, BC4
Contracting Officer

Liability Insurance, Contract NAS9-14000

As the Space Shuttle program completes its development and moves into the operational phase, there has been a significant change in the approach taken by the commercial insurance community toward liability insurance for Space Shuttle activities. As this change significantly increases program costs, we consider it appropriate to notify the Contracting Officer.

Rockwell's general aviation products liability policy for the insurance year which started July 1, 1981 had a policy limit of $1 billion. It covered our Space Shuttle as well as our general aviation activities. Although we have the highest confidence in the products we sell, including the Space Shuttle elements, the terms of our contract as well as prudent risk management dictated that the corporation be protected with such a general liability policy.

As the policy renewal date of July 1, 1982 approached, it became increasingly evident that the insurance underwriters were concerned about the potential liability which could flow from the loss of or damage to expensive payloads which the Shuttle would be carrying during the operational phase. The primary part of this concern was in the potential for consequential damages resulting from loss of revenue from the loss of a communication satellite. It was also evident that Rockwell does not control which payloads would be carried or their potential commercial value. To give the insurance community a better understanding of the Space Shuttle, Rockwell met several times directly with the underwriters (Lloyds of London), with our several insurance brokers and with other insurance industry representatives. In these meetings we acquainted them with the many safeguards built into the Space Shuttle system and the procedures involved in Space Shuttle operations.

The initial dialog started several months ago with the comments from the insurance underwriters that there might be a complete exclusion of Shuttle operations from the policy. The first renewal offer from the underwriters, which was not made until June, was for a policy which would specifically limit the Shuttle operations coverage to $100,000,000 and require a special added Shuttle premium of $3,050,000. The Shuttle portion of the premium for our prior $1 billion policy which expired June 30, 1982 was only $289,000.

cc: A. Cohen, MA, NASA/JSC, Houston, TX
T. R. Kloves, MC, NASA/JSC, Houston, TX
L. W. Methers, BC121, NASA/Downey, CA
W. B. Wilson, MR, NASA/SSPRO, Downey, CA (7)
J. Davison, NE, NASA/OAR&S, Downey, CA

After extensive negotiations, Rockwell negotiated a new liability insurance policy effective as of July 1, 1982 which has the following provisions:

- $1 billion policy limit, Shuttle operations included
- $5,300,000 total annual policy premium
- Shuttle portion of $5,300,000 total is $2,950,000 based on three launches during the policy year
- $2,200,000 Shuttle premium if only two launches
- $1,400,000 Shuttle premium if only one launch
- $150,000 Shuttle premium if NASA contractually indemnifies Rockwell in total prior to STS-5
- $2,900,000 Shuttle premium if NASA contractually indemnifies Rockwell for amounts in excess of $500,000,000 only

The policy has been accepted as a reasonable total package settlement, and it is in force as of July 1, 1982. It should be noted that we have already been advised by one of our minor Shuttle Orbiter subcontractors that they will have to pay an increased premium of approximately $100,000 for Shuttle operations coverage. We assume other suppliers will be notified of premium cost increases as their policies approach renewal.

Rockwell will allocate an appropriate portion of the insurance premium to Contract NAS9-14000 in accordance with our existing accounting policy as reflected in our approved Cost Accounting Standards Disclosure Statement. This requires charging such excess costs direct to the contract. This method has been reviewed with the Government's Rockwell Corporate ACO who has stated he is in general agreement with the approach being taken. We will coordinate with the NASA/JSC Contracting Officer the details of apportioning the direct costs between the several schedules of Contract NAS9-14000."

ROCKWELL INTERNATIONAL
Shuttle Orbiter Division

R. G. Leeth

R. G. Leeth, Director
Contracts & Pricing

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

SEP 11 1981

Honorable Ronnie G. Flippo
Chairman
Subcommittee on Space
Science and Applications
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

The Commerce Committee's Report (No. 97-100) accompanying S. 1098, which authorizes Fiscal Year 1982 funds for NASA, directed NASA to examine two-spacecraft options for the International Solar Polar Mission.

Given the continuing interest of the Subcommittee on Space Science and Applications in the International Solar Polar Mission, I enclose for your interest the report prepared in response to the Commerce Committee's request.

Please let me know if I can be of assistance to you on this matter.

Sincerely,

James M. Beggs
Administrator

Enclosure

cc: Honorable Harold C. Hollenbeck

International Solar Polar Options

The International Solar Polar Mission (ISPM) was originally planned as a joint NASA and European Space Agency (ESA) mission designed to obtain the first view of the solar system from a new perspective -- a view from far above and far below the plane in which the planets orbit the Sun's equator. Due to the FY 1982 Budget Amendment reductions, a major restructuring of the ISPM had to be made. The United States spacecraft development was to be cancelled, though, funding was included in the FY 1982 Amended Budget to support a launch opportunity for the ESA spacecraft in 1986. In addition, NASA planned to support the continuation of United States principal investigation efforts and instrument development on those instruments which would fly on the ESA spacecraft. The deletion of the United States spacecraft would, of course, reduce the total science return of information about the Sun.

However, four two-spacecraft options have continued to be studied in addition to continuing support for a single ESA spacecraft. One backup sheet on each of the five options shown below is attached as Appendix I which lists the preliminary cost estimate, plus the relevant advantages/disadvantages of each option. It should be noted that no costs for launch vehicle or tracking have been included since they are approximately the same for all options including the FY 82 Amended Budget.

Option I: One ESA spacecraft only to be launched in 1986 which was submitted as part of the FY 1982 Amended Budget to Congress. This is the lowest cost option where NASA would provide experiments and associated investigator support for the ESA spacecraft. The ISPM would be launched on a Shuttle/Centaur combination. The reduced involvement by the United States in the mission will reduce the total science return of information about the Sun.

Option II: Two ESA developed spacecraft launched in 1986 which would provide for simultaneous measurements at both poles as originally planned, but neither spacecraft would be able to accommodate the coronagraph or x-ray telescope experiments. This option assumed the second spacecraft would be developed by ESA and provided to the United States at a fixed price of $40 million in FY 1981 dollars.

Option III: A two spacecraft mission launched in 1986 where NASA would develop a simpler spacecraft which would also provide for simultaneous measurements at both poles as originally planned, but the simpler spacecraft would not accommodate the coronagraph or x-ray telescope experiments. It has the added advantage of being a U.S.-developed spacecraft. The cost of this option is higher than the two ESA spacecraft option.

Option IV: Two spacecraft mission launched in 1986 where NASA would develop a simpler spacecraft plus adapt one or more of the elements of the coronagraph for operation on a spinning spacecraft. This option would also provide for simultaneous measurements at both poles as originally planned, but the spinning coronagraph (if it is technically feasible to develop) would provide fewer scientific results than the fully restored mission. It has the advantage of being a U.S. developed spacecraft, however, the cost of this option is higher than the two ESA spacecraft option or the simpler U.S. developed spacecraft without a coronagraph.

Option V: Full restoration of the ISPM with a launch in 1986. (The NASA spacecraft for this option would have the full capability of the despun platform and the coronagraph planned for the originally approved mission.) This option requires additional funding in FY 1982 and subsequent years and the total project cost estimate would increase. The total mission objectives would be accomplished with this option, however, it is the most costly option.

The attached table summarizes the preliminary estimate of the required funding through completion for each of the five options mentioned above.

In addition to the individual option description sheets in Appendix I, Appendix II identifies the manner by which each of the selected investigations contributes to the four major capabilities provided by the mission design for the Solar Polar Mission. These four major capabilities are:

1. Observations at high solar latitude;

2. Separation of spatial and temporal dependences;

3. Stereoscopic observations at two widely separated points;

4. Relationships between the structure and dynamics of the Sun and heliosphere

NASA has taken action to keep all of the listed options viable until a single option can be selected. The current funding will allow all options to be viable until December 1, 1981. At that time, a single option decision is needed to protect carryover funding that is required to support the single ESA spacecraft mission with the funding levels for FY 82 and outyears that are planned in the revised budget. In addition, however, ESA will require a response by October of 1981 in order to protect the viability of their offer. This date is driven by the need to add the second spacecraft procurement to their existing development contract.

A decision related to each of the options should be made as soon as possible to allow both ESA and the United States to take the most cost effective approach to conducting the ISPM leading to a launch in 1986.

INTERNATIONAL SOLAR POLAR OPTIONS

		Launch	FY 79	FY 80	FY 81	FY 82	Balance to Compl.	Total Proj. Cost Range
Option I	ESA Spacecraft only on Shuttle/Centaur (FY 82 Amended Budget Request)	1986	12.5	47.9	28.0	5.0	17-37	110-130
Option II	Two ESA Spacecraft Mission on Shuttle/ Centaur	1986	12.5	47.9	28.0	5.0	142-157	235-250
Option III	Two Spacecraft Mission where NASA would develop a simpler S/C than original mission	1986	12.5	47.9	28.0	5.0	217-237	310-330
Option IV	Two Spacecraft Mission where NASA would develop a simpler S/C & simpler coronagraph than original mission	1986	12.5	47.9	28.0	20.0	272-322	380-430
Option V	Full Restoration of Mission launched on Shuttle/Centaur	1986	12.5	47.9	28.0	30.0	292-342	410-460

OPTION I - FY 82 AMENDED BUDGET

Assumptions: 1 ESA S/C with U.S. and European Science currently assigned to "ESA" Spacecraft wherein NASA would provide:

- 1 RTG (no engineering support)
- "ESA" Spacecraft Science of U.S. PIs
- Launch Vehicle & Services for launch in 1986
- Mission Operations Facilities & Mission Control Center Personnel for 5 yr. operations (Does not include any project unique support or data processing)
- Data Analysis for U.S. Experimenters
- Data Records for all Experiments

Funding:	FY 80 & Prior	81	82	Total
	60.4	28.0	5.0	110-130

Considerations:	Pros	Cons
Science		o 1 S/C Mission o No imaging - loss of important correlative science data
Programmatic	o No Budget Action Required	
International		o Undesirable to ESA

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OPTION II - PROCUREMENT OF SECOND "ESA" SPACECRAFT

Assumptions: Same as Option I - FY 82 Amended Budget except NASA would provide:

2 RTGs (no engineering support)
"ESA and "NASA" Spacecraft Science of U.S. PIs except Despun Imaging. "NASA" instruments modified to ESA S/C interface
$40M (FY 81 $) (Fixed Price) to procure a second ESA spacecraft
Launch Vehicle with kick stage and services for Tandem Launch in 1986 (ESA performs all spacecraft to Launch Vehicle integration)
Mission operations Facilities and Mission Control center personnel for 5 yr. operations (ESA operates both spacecraft and provides any required spacecraft analysis software).
Data Records for all Experiments. Data Analysis for U.S. Experimenters

Funding:	FY 80 & Prior	81	82	Total
	60.4	28.0	5.0	235-250
Δ to FY 82 Revised Budget	--	--	--	105-140

Considerations:	Pros	Cons
Science	o 2 S/C mission (restores 80% science value)	o No imaging - loss of important correlative science data
Programmatic	o No FY 82 budget action req'd o Lowest cost dual S/C option identified	o International fund transfer o Strong U.S. industry reaction expected o > $100M increase in runout over FY 82 Revised Budget
International	o Fixed Price Production of 2nd S/C acceptable to ESA	o ESA may resist providing services beyond S/C production, therefore, higher cost may result from detailed negotiations

OPTION III - PROCUREMENT OF SIMPLER NASA SPACECRAFT WITH NO IMAGING

Assumptions: Same as Option II except that "NASA" Spacecraft would be a simple spinner (no Despun Platform, and no Imaging)

Funding:	FY 80 & Prior	81	82	Total
	60.4	28.0	5.0	310-330
△to FY 82 Revised Budget	--	--	--	180-220

Considerations:	Pros	Cons
Science	o 2 S/C mission (restores 80% science value)	o No imaging - Loss of important Correlative Science
Programmatic	o No FY 82 budget action required	o Requires substantial increase in FY 83 Budget o ∿ $200M increase in runout over FY 82 Revised Budget
International	o Acceptable to ESA	

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APPENDIX II: SCIENTIFIC CAPABILITIES OF THE MISSION OPTIONS

The design of the originally approved mission was based on four major capabilities:

(1) observations at high solar latitude,

(2) separation of spatial and temporal dependences,

(3) stereoscopic observations at two widely separated points,

(4) relations between the structure and dynamics of the sun and the structure and dynamics of the heliosphere.

Table I relates these major capabilities (columns) to the ISPM investigations (rows). The appearance of the letter, P, in a given row or column denotes that the appropriate capability is essential to the primary objectives of the scientific investigation. The capability to observe at high latitudes is dependent on the trajectory and is common to all options. There is an approximate correspondence between the other three capabilities and the various spacecraft options being considered. Stereoscopic observations and the unambiguous separation of spatial and temporal dependences require two spacecraft. Solar images (the CXX) are required in order to relate the in situ and remote sensing observations to the chromosphere and corona.

High latitude observations are basic to most of the investigations. A primary objective of the mission is to determine the in situ properties of the solar wind, the heliospheric magnetic field, plasma waves, solar energetic particles and cosmic rays in the third dimension. Major objectives in imaging the chromosphere and corona are to view the high latitude polar cap regions for the first time and to view the corona from above as it rotates with the sun. Such observations will provide new understanding of the three dimensional structure of the corona, the influence of coronal structure on the origin and properties of the solar wind and the relationship of the solar wind and corona to underlying solar phenomena. The cosmic dust cloud will be observed from above and outside it and astronomical observations will become possible to low light levels. Interstellar gas entering the solar system will be sampled directly and observed photometrically from a perspective that is essentially orthogonal to that of past observations.

The separation of spatial (structural) dependences from temporal (dynamical) dependences is fundamental to the investigations making in situ observations. The sun, especially its outer atmosphere, is characterized by extreme variability over a broad range of time scales and intensities. To determine the structure of the polar magnetic field, the solar wind issuing from the polar corona, and the properties of plasma waves, galactic cosmic rays and solar energetic particles as a function of solar latitude, it will be necessary to identify time variations unambiguously. In particular, it will take the spacecraft approximately onehalf year (six solar rotations) to go from one solar pole to the other. Major restructuring of the chromosphere and corona can be anticipated during this interval. Such changes are especially likely as the observations will be made at, or near, the maximum in solar activity. As a result, conditions are almost certain to be different in the two solar hemispheres and simultaneous observations will be required to prevent time changes from masking from differences that are characteristic of the two hemispheres.

Many of the primary objectives of the remote sensing experiments require simultaneous measurements at two widely-separated locations. Direction-finding techniques will make it possible to locate solar radio bursts and to trace their sources as they travel outward through the corona and into the heliosphere. The intensity of the x-rays from solar flares will be measured along two different directions to determine the extent to which the radiation is isotropic. Precise timing of the arrival of cosmic gamma ray bursts at the two spacecraft will be used to triangulate on their astrophysical sources. The properties of the interplanetary dust inferred from Zodiacal light measurements on one spacecraft will be compared with direct detection of dust particles on the other spacecraft.

The Coronagraph-X ray-XUV Telescope provides the capability (a) to relate the properties of the magnetized solar wind to the outer corona, (b) to correlate heliospheric disturbances with coronal transients and (c) to identify conditions in the chromosphere in the vicinity of the solar flares which produce the radio bursts, energetic particles and x-rays. This unique capability will be especially valuable when the spacecraft is at high latitude and the solar wind and magnetic field are originating from regions which cannot be viewed from within the ecliptic.

The optional missions now being considered result in a reduction of these capabilities and imply major science losses. Tables II and III address the issue of science loss for the dual spacecraft missions without solar imaging, and the single spacecraft mission, respectively. The format of these tables is the same as in Table I, making it easy to compare them. In Tables II and III, crosses (X) have replaced the Ps in Table I in cases where the loss of a capability strongly degrades the primary scientific objectives of an investigation.

Table II shows the science reductions if two spacecraft are retained but solar imaging is eliminated (no CXX). The scientific results associated with the two parts of the investigation are lost so no information is obtained on either the chromosphere and low corona (the x ray XUV telescope) or the outer corona (the white light coronagraph). In addition, significant science reduction occurs with the elimination of the correlation between these observations both the in situ (local) and remote sensing (transient) observations.

It might be presumed that correlative studies could be carried out using solar observations from sources other than the CXX, such as ground-based observations or solar telescopes carried on satellites orbiting the Earth. However, ground-based observations are not a realistic substitute for space observations. X-ray and extreme ultraviolet solar radiation are absorbed by our atmosphere and do not penetrate to the Earth's surface. Terrestrial coronagraphs are limited by sky brightness and are only able to detect the inner corona within about 2 solar radii of the sun's surface. By contrast, the solar wind is thought to originate at, or beyond, 10 solar radii. There are also serious limitations associated with observations by Earth satellites. There are no definite plans to have the appropriate Coronagraph, X-ray, XUV Telescope in space during the Solar Polar Mission. If such observations become possible, correlation with the high latitude measurements will inevitably suffer from the foreshortening effects that are inherent to all in-ecliptic observations. Furthermore, during a significant fraction of the approved mission, the spacecraft and the Earth will be on opposite sides of the sun.

Table III shows the reduction in science for the single ESA spacecraft mission. The two major capabilities associated with observations at two points in space would be lost. The cross in row 2 (solar wind), column 3 (stereo) denotes a significant loss to the Radio Science Investigation (RSI) whose primary objective is to use the radio telemetry from the two spacecraft to probe the solar wind near the sun (inside 20 or 30 solar radii). The cross in the row labelled, Dust, and the Stereo column indicates the loss of the Zodiacal light investigation on the NASA spacecraft (which, strictly speaking, is complementary to the direct measurement of dust particles rather than providing a stereoscopic capability). Crosses in the first column indicate the loss of observations from both the CXX and the interstellar gas investigations, both of which are carried only on the NASA spacecraft.

OPTION IV - PROCUREMENT OF SIMPLER NASA SPACECRAFT WITH MINIMUM IMAGING (WITH SPINNING WHITE LIGHT CORONAGRAPH)

Assumptions: Same as Option III with the incorporation of a spinning White Light Coronagraph

Funding:	FY 80 & Prior	81	82	Total
	60.4	28.0	15-20	380-430
Δto FY 82 Revised Budget			10-25	250-320

Considerations:	Pros	Cons
Science	o 2 S/C mission (restores 90% science value) o White Light Spinning Coronagraph added with important science value	o Spinning White Light Coronagraph may be a high risk development
Programmatic		o Requires restoration of funds in FY 82 o ~$300M increase in runout over FY 82 Revised Budget
International	o Acceptable to ESA	

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OPTION V - FULL RESTORATION OF TWO SPACECRAFT MISSION FOR 1986 LAUNCH

Assumptions: Reinstatement of NASA S/C with full imaging capability
Distribution of responsibilities would be per Memorandum of Understanding; and Tandem Launch would be provided in 1986

Funding:	FY 80 & Prior	81	82	Total
	60.4	28.0	15-30	410-460
Δto FY 82 Revised Budget	--		10-25	280-350

Considerations:	Pros	Cons
Science	o 2 S/C mission (restores 100% science value) o Full imaging capability	
Programmatic		o Requires restoration of funds in FY 82 o ≈$300M increase in runout over FY 82 Revised Budget
International	o Acceptable to ESA	

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TABLE I

APPROVED MISSION (ESA SPACECRAFT, NASA SPACECRAFT WITH DESPUN PLATFORM)

	HIGH LATITUDE OBSERVATIONS (TRAJECTORY)	SPATIAL-TEMPORAL SEPARATION (2 SPACECRAFT)	STEREOSCOPIC OBSERVATIONS (2 SPACECRAFT)	SOLAR-HELIOSPHERIC RELATIONS (CXX)
MAGNETIC FIELD (HED, MAG)	P	P		P
SOLAR WIND (BAM, GLG, SWE, RSI)	P	P		P
COSMIC RAYS (SIM, CPA)	P	P		P
PLASMA WAVES (RAP, STO)	P	P		
SOLAR ENERGETIC PARTICLES (SIM, CPA, LAN, KEP)	P	P		P
SOLAR RADIO WAVES (RAP-STO)			P	P
SOLAR X-RAYS (HUS-SXR)			P	P
CORONAGRAPH, X-RAY, XUV TELESCOPE (CXX)	P			P
DUST (GRU, ZLE)	P		P	
INTERSTELLAR GAS (GAS)	P			
GAMMA RAY BURSTS (HUS-SXR)			P	

TABLE II

TWO SPACECRAFT (W/O CXX)

	HIGH LATITUDE OBSERVATIONS (TRAJECTORY)	SPATIAL-TEMPORAL SEPARATION (2 SPACECRAFT)	STEREOSCOPIC OBSERVATIONS (2 SPACECRAFT)	SOLAR-HELIOSPHERIC RELATIONS (CXX)
MAGNETIC FIELD (HED, MAG)	P	P		X
SOLAR WIND (BAM, GLG, SWE, RSI)	P	P		X
COSMIC RAYS (SIM, CPA)	P	P		X
PLASMA WAVES (RAP, STO)	P	P		X
SOLAR ENERGETIC PARTICLES (SIM, CPA, LAN, KEP)	P	P		X
SOLAR RADIO WAVES (RAP-STO)			P	X
SOLAR X-RAYS (HUS-SXR)			P	X
CORONAGRAPH, X-RAY, XUV TELESCOPE (CXX)	X			X
DUST (GRU, ZLE)	P		P	
INTERSTELLAR GAS (GAS)	P			
GAMMA RAY BURSTS (HUS-SXR)			P	

TABLE III

SINGLE ESA SPACECRAFT

	HIGH LATITUDE OBSERVATIONS (TRAJECTORY)	SPATIAL-TEMPORAL SEPARATION (2 SPACECRAFT)	STEREOSCOPIC OBSERVATIONS (2 SPACECRAFT)	SOLAR-HELIOSPHERIC RELATIONS (CXX)
MAGNETIC FIELD (HED, MAG)	P	X		X
SOLAR WIND (BAM, GLG, SWE, RSI)	P	X	X (RSI)	X
COSMIC RAYS (SIM, CPA)	P	X		X
PLASMA WAVES (RAP, STO)	P	X		
SOLAR ENERGETIC PARTICLES (SIM, CPA, LAN, KEP)	P	X		X
SOLAR RADIO WAVES (RAP-STO)			X	X
SOLAR X-RAYS (HUS-SXR)	P		X	X
CORONAGRAPH, X-RAY, XUV TELESCOPE (CXX)	X			X
DUST (GRU, ZLE)	P		X	
INTERSTELLAR GAS (GAS)	X			
GAMMA RAY BURSTS (HUS-SXR)	P		X	

National Aeronautics and
Space Administration

Washington, D.C.
20546

C:LH:gjb

FEB 9 1982

Mr. Darrell Branscome
Staff Director
Subcommittee on Space
Science and Applications
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Darrell:

Enclosed for your information is the Report on Major Equipment Approved for Acquisition during FY 1981.

Sincerely,

John F. Murphy
Director, Office of
Legislative Affairs

Enclosure

TABLE III

SINGLE ESA SPACECRAFT

	HIGH LATITUDE OBSERVATIONS (TRAJECTORY)	SPATIAL-TEMPORAL SEPARATION (2 SPACECRAFT)	STEREOSCOPIC OBSERVATIONS (2 SPACECRAFT)	SOLAR-HELIOSPHERIC RELATIONS (CXX)
MAGNETIC FIELD (HED, MAG)	P	X		X
SOLAR WIND (BAM, GLG, SWE, RSI)	P	X	X (RSI)	X
COSMIC RAYS (SIM, CPA)	P	X		X
PLASMA WAVES (RAP, STO)	P	X		
SOLAR ENERGETIC PARTICLES (SIM, CPA, LAN, KEP)	P	X		X
SOLAR RADIO WAVES (RAP-STO)			X	X
SOLAR X-RAYS (HUS-SXR)	P		X	X
CORONAGRAPH, X-RAY, XUV TELESCOPE (CXX)	X			X
DUST (GRU, ZLE)	P		X	
INTERSTELLAR GAS (GAS)	X			
GAMMA RAY BURSTS (HUS-SXR)	P		X	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
REPORT ON MAJOR EQUIPMENT
APPROVED FOR ACQUISITION
FISCAL YEAR 1981

Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Ames Research Center	Data Acquisition System. An air framed propulsion calibration system.	Obtain data in wind tunnels for model engines for jet airplanes.	Purchase	$ 265,000	R&D/Aeronautical Research and Technology and IMS	
Ames Research Center	Laser Low Airspeed Sensor and Processor	Laser system used on aerodynamic helicopter.	Purchase	$ 437,000	R&D/Aeronautical Research and Technology	
Goddard Space Flight Center	Space Telescope Operations Control Center Data System	Conduct real-time operation of the Space Telescope Observatory with planned mission life of 17 years.	New Procurement	$5,100,000	R&D/Space Tracking and Data Acquisition	
Goddard Space Flight Center	System to capture Spacelab payload data up to 50 Mbs (Peak) of composite experiments, demultiplex and preprocess.	Support Spacelab missions.	New Procurement	$5,500,000	R&D/Space Tracking and Data Acquisition	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Goddard Space Flight Center	Univac 1100/82 Computer.	Replace aging and unreliable Univac 1108 machine. Serves as output processor for Spacelab data and processes science data for production of experimenter data tapes for free flyer spacecraft.	New Procurement	$1,100,000	R&D/Space Tracking and Data Acquisition	
Goddard Space Flight Center	Mission Operations Computing Facility (MOCF) required to replace Flight Dynamics System (FDS).	Provide mission analysis and attitude computing capability to Goddard Payload Operating Control Centers (POCC's) as required.	New Procurement - Lease	$ 300,000	R&D/Space Tracking and Data Acquisition	No responsive proposals received to RFP in FY81; procurement restructured for hardware lease in FY82 and FY83.
Goddard Space Flight Center	Mission Operations Computing Facility (MOCF) required to replace Command Management System (CMS).	Provide on-board management support computing capability to Goddard POCC's as required.	New Procurement	$ 300,000	R&D/Space Tracking and Data Acquisition	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Goddard Space Flight Center	POCC Pilot Model (POCCNET). This acquisition comprises the design and procurement of several mini/midi computers and peripherals to be used as a nucleus for the POCCNET pilot model POCC. The pilot model will demonstrate the concept of distributed processing virtual peripherals, common software, shared resources and computer networking.	Support the mission control workload in the 1980's and beyond in order to meet quick turnaround, increased support efficiency requirements and to minimize development and recurring costs with each new mission. The POCCNET concept is envisioned as very cost effective in the TDRSS/STS/Spacelab era.	New Procurement	$ 800,000	R&D	
Goddard Space Flight Center	Mission Operations Computing Facility (MOCF). Required to replace obsolete Orbit Computing System (OCS).	Provide mission operations orbit support computing capability to Goddard projects.	New Procurement	$ 200,000	R&D/Space Tracking and Data Acquisition	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Goddard Space Flight Center	Science and Applications Computing Center (SACC) Upgrade	Replace the current SACC equipment with a new computer system that will include an on-line mass storage device to meet Office of Space Science and Applications (OSSA) program requirements, including support for some academic scientists. Current SACC equipment (installed in 1967) is obsolete and will not meet the computing requirements of OSSA programs in FY 82 and beyond.	Lease	$ 1,047,000	R&D/Physics and Astronomy and Planetary Exploration	
Goddard Space Flight Center	Vertical Atmospheric Sounder (VAS) Assessment Processor, which is a Digital Equipment Corp. (DEC) VAX 11/780 and peripheral complement.	Assimilate VAS plus ancillary data to form a four dimensional set appropriate for model initialization and impact studies. This equipment is required for the utilization of geosynchronous VAS data in model impact studies. These data provide heretofore unavailable temporal resolution consistent with severe local convective storms.	Purchase	$ 452,000	R&D/Space Applications	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Goddard Space Flight Center	Automatic data processing system to augment existing Amdahl 470 V/6.	Extend present capability to accommodate excessive data volume and processing speeds required for assigned NASA role in the Global Atmospheric Research Program (GARP) of assessing the impact of satellite meteorologic observations on global forecast systems.	Lease/Purchase Agreement	$ 1,040,000	R&D/Space Applications	
Goddard Space Flight Center	Lease of high speed tape drives, controllers, disk storage equipment, supporting software, software libraries, ADP card punch computer train driver, terminal control unit, and data lines for the Amdahl Computer System.	Extend present capability to accommodate excessive data volume and processing speeds required for assigned NASA role in the Global Atmospheric Research Program (GARP) of assessing the impact of satellite meteorologic observations on global forecast systems.	Lease	$ 186,000	R&D/Space Applications	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Goddard Space Flight Center	Lease of Terrabit Memory to be used on the Amdahl Computer System.	Extend present capability to accommodate excessive data volume and processing speeds required for assigned NASA role in the Global Atmospheric Research Program (GARP) of assessing the impact of satellite meteorologic observations on global forecast systems.	Lease	$ 40,000	R&D/Space Applications	
Goddard Space Flight Center	Landsat-D Ground Support System consisting of the Operations Control Center, Data Management System, Landsat-D Assessment System, and Transportable Ground Station.	Support the Landsat-D mission as described and supported in the Landsat-D rebaselined project plan.	Purchase	$ 13,162,000	R&D/Space Applications	
Johnson Space Center	Guidance Navigation System (GNS)	Univac 1100/44 for GNS Level II.	Development Contract	$ 700,000	R&D/Space Shuttle	
Johnson Space Center	Shuttle Data Processing Complex	Replace computers in the Real Time Computer Center.	Development Contract	$ 181,000	R&D/Space Shuttle	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Johnson Space Center	Network Interface Processor (NIP)	Interface the Orbiter Multirate Data Systems from the Space Tracking Data Network/Tracking Data Relay Satellite to the Mission Control Center (MCC).	Development Contract	$ 747,000	R&D/Space Shuttle	
Johnson Space Center	Master Interface Timing	Provides the Central Timing System for the MCC.	Development Contract	$ 20,000	R&D/Space Shuttle	
Johnson Space Center	Wideband Recorder/Switch	Provide capability for recording all input data to the MCC.	Development Contract	$ 681,000	R&D/Space Shuttle	
Johnson Space Center	Display Control/Shuttle Data Processing Complex Interface	Provide display control system and its interface to the Shuttle Data Processing Complex.	Development Contract	$ 2,134,000	R&D/Space Shuttle	
Johnson Space Center	Orbiter Data Reduction Complex	Data processing support for the Orbital Flight Test, Shuttle Avionics Integration Laboratory, Orbiter Ground Tests, and Shuttle Program Information Management System.	Development Contract	$ 909,000	R&D/Space Shuttle	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Johnson Space Center	Digital Voice	Interface MCC and onboard voice systems.	Development Contract	$ 183,000	R&D/Space Shuttle	
Johnson Space Center	Spacelab Simulator	Simulator for flight crew training on Spacelab.	Development Contract	$ 300,000	R&D/Space Shuttle	
Johnson Space Center	Data Dump Facility	Process all recording data onboard the Orbiter.	Development Contract	$ 98,000	R&D/Space Shuttle	
Johnson Space Center	Payload Operating Control Center (POCC) Decommutator	Simultaneous processing of payload data.	Development Contract	$ 122,000	R&D/Space Shuttle	
Johnson Space Center	Wideband Interface	Bring independent payload high rate data into the Mission Control Center.	Development Contract	$ 885,000	R&D/Space Shuttle	
Johnson Space Center	Payload Data Interleaver (PDI) System	Process and display Orbiter downlink data through the PDI.	Development Contract	$ 1,000	R&D/Space Shuttle	
Johnson Space Center	Onboard TV	Preview capability of downlink video prior to release.	Development Contract	$ 118,000	R&D/Space Shuttle	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Johnson Space Center	Life Science Payloads Monitoring Area, Support Data Systems, and Display Equipment	Provide real-time monitoring of Life Science Shuttle experiments.	Support Contractor	$ 654,000	R&D/Life Sciences	
Johnson Space Center	Reconfiguration Data Collection System	Collect reconfiguration data and construct tables for reconfiguration of Mission Control Center.	Development Contract	$ 318,000	R&D/Space Shuttle	
Johnson Space Center	Payload Operating Control Center (POCC) Display Control	Display experiment systems data.	Development Contract	$ 230,000	R&D/Space Shuttle	
Johnson Space Center	III Model FR80 Microfiche	Upgrade and replace current FR80 equipment.	Development Contract	$ 81,000	R&D/Space Shuttle	
Johnson Space Center	NASA Encryption	Provide secure uplink and downlink.	Development Contract	$ 391,000	R&D/Space Shuttle	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
REPORT ON MAJOR EQUIPMENT
APPROVED FOR ACQUISITION
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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Johnson Space Center	Earth Observations Division Laboratory System	Process Landsat data used in the AgRISTARS Program.	Support Contractor	$ 1,149,000	R&D/Space Applications	
Johnson Space Center	Ion Microprobe Mass Analyzer	For geological/geochemical scientific studies.	Development Contract	$ 151,000	R&D/Planetary Exploration	
Johnson Space Center	1100/81 Hardware Lease/Purchase	Augment the Central Computing Facility.	Development Contract	$ 754,000	R&D/Space Shuttle	
Kennedy Space Center	Multi-Test/Multi-Flow and Software Production Facility	Increase capability of Launch Processing System (LPS) hardware to support the mission model of 24 missions per year.	Cost plus Fixed Price Contract	$ 2,774,000	R&D/Space Shuttle	
Lewis Research Center	SEQM Electron Microprobe Analyzer. An electron microscope capable of chemically analyzing regions as small as 0.00004 inches.	Study of minute chemical changes that occur when materials react with their environment. It is applicable to a broad range of studies, such as the degradation of turbine blade coatings by various engine exhaust gases.	Negotiated Competitive Purchase	$ 356,924	R&D/Aeronautical Research and Technology	

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Receiving Installation	Equipment Description	Purpose	Acquisition Method	FY 1981 Obligations	Fund Source	Remarks
Lewis Research Center	Ultraviolet/Electron Spectroscope. Used primarily to determine the chemical composition of surfaces and material interfaces.	Aid investigation of semi-conductor materials for microwave circuit application.	Advertised Purchase	$ 251,460	R&D/Aeronautical Research and Technology	
Wallops Flight Center	Data Mill 700, horizontal milling machine	Perform fabrication work for the Sounding Rocket Program.	Purchase with trade-in allowance	$ 285,000	R&D/Physics and Astronomy	$154,000 actual cost; $131,000 trade-in allowance on four old machines.

National Aeronautics and
Space Administration

Washington, D.C.
20546

C:RVL:cwt

MAR 11 1982

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

As requested in House Report 97-32 (page 23) accompanying H.R. 1257, the NASA Authorization bill for FY 1982, enclosed is a summary for Calendar Year 1981 of the recommendations to the NASA Administrator made by the NASA Advisory Council and the committees that report to it.

As has been agreed separately, we will provide to the staffs of the pertinent Subcommittees on a continuing basis, minutes of all future Council and Advisory Committee meetings. These minutes will contain from time-to-time recommendations both at the Administrator and program Associate Administrator levels. At the end of the calendar year, we will again provide a summary of recommendations to the Administrator comparable to that enclosed herein.

Sincerely,

John F. Murphy
Assistant Administrator
for Legislative Affairs

Enclosures

2/17/82

NASA ADVISORY COUNCIL (NAC)
GUIDANCE AND RECOMMENDATIONS - 1981

April 9, Kennedy Space Center

1. NAC supported the FY 82 budget as proposed to Congress.

2. NAC provided the following guidance to program Associate Administrators for use in preparing their plans.

   a. Space and Terrestrial Applications - suggested criteria for decisionmaking on technology demonstration projects.

   b. Space Science - supported ISPM, Galileo/Centaur, and Space Telescope and expressed concern about lost opportunities and feared loss of space science teams.

   c. Aeronautics - supported the ASEB/Stever recommendations on NASA's role; funding for composite materials (LCPAS) program, Numerical Aerodynamics Simulator (NAS), and critical materials program; and acceleration of advanced prop-fan research.

3. Aeronautics - NAC recommended that:

   a. A delegation meet with the OMB Director to request re-examination of the merits of the Aeronautics Program budget in light of the ASEB/Stever Report.

   b. NASA consider a program for working with the FAA in research to improve aircraft safety where there is new technology requiring appropriate standards.

4. Space and Terrestrial Applications - NAC recommended that:

   a. NASA meet with NOAA to consider a NASA-sponsored interdisciplinary symposium to focus on the state of the art in remote sensing and its potential contributions to current fundamental questions about coastal zone dynamics and management.

August 3-4, La Jolla

The NAC generally endorsed the program strategies proposed by NASA for FY 1983 planning and the associated committee reports. They emphasized in their recommendations:

1. Full support for bringing Shuttle to operational service as soon as possible.

2. Funding other space activities and aeronautics on an individually rational basis and funding any further increases in Shuttle funding through a corresponding increase in the NASA budget rather than through reductions in aeronautics and space programs.

3. That the following criteria be used in evaluating expanded or new science and aeronautics programs:

   a. Programs already underway should be granted higher priority than proposed new initiatives (even those of equal value) to ensure that present investment and momentum are not lost.

   b. Evaluation of proposed new initiatives should include these factors:

   - their contribution to the achievement of the National aeronautics and space policy goals and objectives which represent a consensus of the specialized communities that NASA now serves
   - their contribution to continued advancement of knowledge which is NASA's prime purpose
   - for space initiatives, effective use of the Space Transportation System
   - maintenance of program continuity and of a stable, technically creative institutional base supported by adequate facilities
   - advance of future options

4. Identification of new space program goals to add to presently established goals. Candidate goals under Council evaluation are cited as examples.

5. Aeronautics - support for the national policy of preeminence in aeronautics and NASA's role recommended in the 1980 ASEB/Stever Report, as well as a policy of appropriate technology demonstration and validation projects.

6. Space Science - support for proceeding with GRO & VOIR without further delay, restoration of the US ISPM spacecraft, an increase in the Explorer budget to $80-100 million per year, as well as initiation of a meaningful Halleys Comet mission.

7. Space and Terrestrial Applications - support for a policy of appropriate demonstration projects (the proposed criteria include (a) when clearly in the national interest and (b) when, because of total cost, risk, or the long term nature of any return, the private sector is unable or unlikely to undertake them alone); the 30/20 GHz program including flight demonstration; and additional emphasis on earth observation remote sensors and data application techniques (with DOD) to protect U.S. leadership and ensure viable commercialization.

8. Space Technology - support for the proposed funding level to restore the program to its past level; and a policy of flight demonstration projects to aid technology transfer within NASA.

September 30, Headquarters

NAC Recommended:

1. Proceeding with the Goals Study. The candidate long range goals are:

   a. to achieve the capability to enable future generations to establish self-sustaining human habitations in space when they should decide to do so.

   b. to understand the present human habitat as a total biogeochemical system and to develop the space systems required to predict its behavior, protect it from natural or man-made catastrophes, and use extraterrestrial resources to help meet its needs.

2. Establishment of a NAC ad hoc subcommittee to review NASA's planning for earth orbital activities, including the potential requirements and such options as platforms and stations, and to prepare for the Council a critique of present planning and recommendations for NASA action.

Formal Reports, CY 1981

1. Report to NASA Administrator on FY 1983 Long Range Planning, October 9, 1981

2. Position Paper - A new role for NASA vis-a-vis FAA, January 1, 1981

8/3/81

SUMMARY MINUTES OF THE
NASA ADVISORY COUNCIL
APRIL 9, 1981
KENNEDY SPACE CENTER, FLORIDA

I. Attendees:

Chairman:	William A. Nierenberg
Members Present:	A.G.W. Cameron Morris Cohen Kingsley Davis Peter B. Dews Willis M. Hawkins Robert L. Johnson Elliott Levinthal James N. Lew Robert G. Loewy James A. Michener John E. Naugle James W. Plummer Laurence A. Soderblom Winona B. Vernberg Holden W. Withington
Members Absent:	Randolph W. Bromery George W. Field Daniel J. Fink John W. Firor Sylvia D. Fries Roger G. Noll Robert W. Rummel William P. Slichter Clifford V. Smith
Invited Participant:	H. Guyford Stever
Executive Secretary:	Nathaniel B. Cohen
Assistant Executive Secretary:	Carl R. Praktish
NASA Headquarters Personnel:	Ivan Bekey Anthony Calio H. Christine Childers David Morrison Walter Olstad William P. Raney Stanley R. Sadin Jon Michael Smith Andrew J. Stofan Michael Weeks Stanley I. Weiss

KSC Personnel: Rebecca J. Kleinschmidt
Andrew J. Pickett
James M. Ragusa
Emmett G. Sherrill
James Spears

Visitor and Affiliation: David Cummings, Universities Space Research Association

II. Agenda:
The agenda is Attachment 1. Not all the topics could be covered because of the limited time. The presentation material on file includes:

Items	Description
1.	Revised NASA Program and Guidelines (FY 1982 Budget Amendments...Details)
2.	Report to NASA Advisory Council, April 9, 1981, John Firor
3.	NASA Advisory Council, April 9, 1981, NASA Applications Program, A.J. Calio
4.	Presentation to the NASA Advisory Council, Office of Space Science, Andrew J. Stofan
5.	Briefing to NASA Advisory Council, Spacelab Utilization, April 9, 1981, Jesse W. Moore
6.	Space Shuttle Program, STS-1 Mission
7.	Briefing to the NASA Advisory Council, Chester M. Lee, KSC, April 9, 1981

III. Meeting Highlights
This Council meeting focused on:

A. The questions facing NASA as the result of the budget guidelines, as well as the FY82 budget proposed by the new Administration. The questions are of such a nature as to require further study and recommendations from the appropriate Committee Chairmen before the Council could take a position.

[illegible] on the Shuttle program including the STS-1 mission, test program, and the planned utilization of Shuttle and [illegible] delineated in attendance at the first STS-1 launch

C. Council member reports which were acted upon.

IV. Revised Program, Guidelines and Questions

A. Overview

The Assistant to the Acting Administrator welcomed the Council members. He introduced the overview of the program budget by noting these guidelines received from the Administration.

o Do nothing to inhibit development and utilization of the Shuttle and its capability except to plan for reduced use because of reductions in the science and applications program;

o Match the profile for FY82-85 funding which leaves no funds for new starts in FY83 and only $100 million for new starts in FY84;

o Maintain the base since there would be support for the civil space program once the economic objectives had been reached; and

o Leave near term technology transfer/demonstration projects for users.

The Acting Chief Scientist, after summarizing the sequence of reviews and decisions leading to the FY82 program budget, described the program that was presented to Congress. Although a number of worthy programs were reduced or deferred, the FY82 budget represents a slight growth over FY81. He was concerned that disagreements in Congress over priorities could result in changes in the program proposed by NASA in the budget through deletion of programs on which there was a lack of unanimity among the congressional committees.

In order for planning to proceed realistically, such questions as these must be answered:

1. Aeronautics

Is NASA's role to be R&T without technology validation/demonstration? This question is raised by cancellation of the large composite primary structures program.

2. Space Sciences

a. Will new starts continue to be deferred because of evolving budget pressures that led to deferral of new starts again this year?

b. Should NASA plan on giving up the balanced program approach in favor of focusing on some areas while abandoning others? Due to inflation space sciences will have only one-half the resources it had in 1970.

c. What can be done to preserve Galileo, which may be in real jeopardy if there is further delay due to the lack of a suitable "upper stage" propulsion system by 1985?

d. What should the strategy be for exploring the outer planets and what action should NASA take with respect to SEPS, which at present has neither technology nor development funding?

3. Applications

a. What direction should the Applications program take now that the principle of technology validation/demonstration projects has been called into question as an unnecessary subsidy to users? Should it become an R&D program or should NASA seek clarification of the policy since there are valid reasons for such projects?

b. While development is continuing on UARS and its instrumentation, what is needed to get a firm commitment for a flight date?

c. How should the oceans program strategy be revised now that NOSS has been deleted?

d. What directions should the materials program take, given the continued deferrals that have disillusioned team members and users and reduced it to a marginal program?

4. Space Transportation Systems

a. Does the loss of space science and applications payloads, as well as the reduction in the Shuttle operational budget, mean severe curtailment of the civil utility of the Shuttle and what can be done to recover the situation?

b. Are we making effective utilization of the first Spacelab at the time we are committed to buying a second one?

c. What should the role of Spacelab be vs. emphasis on space platforms?

B. Space and Terrestrial Applications

The Associate Administrator presented the Committee Chairman's Report and added that his report was essentially similar. In addition to specific programmatic issues, there is a fundamental policy question in both reports:

Should the Applications Program seek clarification of the policy on technology demonstration projects? Technology demonstration projects have been fundamental to the program and considered necessary for

technology transfer. Are they still needed and justifiable? If so, what are the most productive sectors of the user community to work with?

A corollary question is: should the program expand its role to operations and delivery of information products to users?

C. Aeronautics

The Chairman of the ASEB Workshop on NASA's role in aeronautics began this review by describing the very real demand for NASA's program by the aeronautics community. NASA has historically maintained the nation's preeminence in aeronautics technology and such technology advances are needed if industry is to compete successfully with foreign companies subsidized by their government. For example, the large transport fleet will have to be replaced shortly and the country/region that offers fuel efficient aircraft will dominate this market. As a Council member added, the industry's concern is not competition against another company, but against the resources of other governments. Another Council member added that the aircraft industry would never receive the incentives sufficient to undertake the R&D role NASA has successfully carried out for decades.

The Aeronautics Committee Chairman noted the Committee was disappointed with the few new starts in the Carter budget; now there are none. In only the last two years, the Aeronautics budget has declined over 30% with inflation. He cited the importance of such deferred/reduced programs as the advanced turboprop and large composite primary aircraft structures for the next generation of increasingly fuel efficient aircraft. He concluded with the comment that, given the concern about the validation and technology demonstration projects, his committee would evaluate each one in terms of the Stever Committee criteria.

The Acting Associate Administrator for Aeronautics added that the Aeronautics budget should not have to "compete" with the Shuttle budget - both serve important national goals. NACA came into being and expanded in response to growing foreign competition and NASA and the industry again face this situation. As for a policy to encourage industry to undertake more of a role in validation and technology demonstration, he believed the ability of the industry to make such investments appears to be overestimated -- this may need to be studied in a Woods Hole type workshop. Should the current program budget guidelines continue as policy, NASA will have to find ways for industry to use facilities and exchange personnel rather than turn to formal cost sharing arrangements.

D. Space Science

After the Committee Chairman summarized the discoveries from the highly successful Voyager encounter with Saturn, the Acting Associate Administrator outlined the rationale for such hard choices in the FY82 budget as the cancellation of the U.S. spacecraft for the ISPM. He also summarized the difficult needs he faces in planning the future program.

1. The need to maintain progress on the Space Telescope and Galileo as well as begin VOIR and GRO.

2. The need to determine the Administration's space science goals in order to be able to develop the optimum program strategies.

3. The need to maintain the institutional base, both inhouse and in the university research community, in a time of declining opportunities.

4. The need to develop future technology when long range planning is so uncertain.

E. Actions

After discussion, the Council authorized the Chairman on its behalf to send:

1. A letter to the Acting Administrator expressing its admiration for guiding NASA through the changing administration, policies, budget, as well as his work on Shuttle (done).

2. A letter to the new Administrator expressing its support for the Administration's FY82 budget as presented to Congress and its guidance on the policy questions as developed by the appropriate Committee Chairman. (Done; the Committee Chairmen's guidance is enclosed as Attachments 2-4. Because of the delay in the appointment of the new Administrator, the purpose of the letter has been revised. The Attachments have been sent to the appropriate Associate Administrators and a letter introducing the Council has been sent to the new Administrator.)

3. A small group, if authorized by the new Administrator, to meet with the OMB Director in order to request re-examination of the merits of the aeronautics program budget in light of the Stever/ASEB Committee report. This group would include the Council Chairman, Dr. Stever, the Aeronautics Advisory Committee Chairman and such others as appropriate (in process).

V. Space Transportation

The Director of Space Transportation System Utilization outlined the objectives/events of the first Shuttle flight and the test philosophy for subsequent missions. He and the Director of the Spacelab Flight Division discussed the issues facing NASA in the use of Shuttle and Spacelab capabilities. The Shuttle Operations Program has completed a study of the problems with payload procedures and made efforts to simplify them; in many cases, this is simply a process of maturation in operations. However, the fundamental question is the availability of Shuttle to civil users in view of the cuts in Shuttle flight operations budget. This is currently under study. In the case of Spacelab, a great deal of hardware/experiments could be ready to fly

in the next few years, but the budget means a substantial reduction in flight opportunities over what was planned less than two years ago. Programs such as physics and astronomy have felt the impact severely. The fundamental concern is to assure the appropriate utilization of Spacelab for Space Science and Applications programs.

VI. Reports

A. Proposal for FAA/NASA Cooperation

Based on the findings of the National Research Council's (NRC) study, "Improving Aircraft Safety," the Aeronautics Advisory Committee Chairman identified an important opportunity for the FAA to use NASA's research resources to both attract and hold the necessary technical expertise for airworthiness certification, and develop the research data base for reasonable and appropriate certification standards compatible with advanced technology. The Army/NASA partnership on aeronautics research demonstrates how the concept could work effectively.

ACTION:

The proposal is to be circulated to Council members for concurrence and then transmitted to NASA for appropriate discussions with the FAA. (done).

B. Proposal for Symposium

Dr. Vernberg proposed that an Academy sponsored inter-disciplinary symposium be held to focus on the state of the art in remote sensing and its potential contributions to current fundamental questions about coastal zone dynamics and management. It would bring together remote sensing specialists, coastal zone scientists, and environmental managers to address both general problems and research at specific sites.

ACTION:

The Council endorsed the report for transmittal to NASA management with the guidance that, since NASA does not have lead responsibility in coastal zone management, NASA should open discussions with NOAA and other involved agencies on the possibility of jointly sponsoring such a symposium. The Space Applications Board of the NAS/NAE provides an appropriate capability to organize and sponsor the symposium and Jim Plummer, its chairman, indicated his interest. (done)

C. History Committee Report

Dr. Fries' report had been sent to all Council members in advance of the meeting. Discussion was not necessary since action was straightforward.

8

ACTION:

The Council accepted the report for transmittal to NASA management for appropriate action. (done)

Carl R Praktish
Carl R. Praktish
Assistant Executive Secretary
NASA Advisory Council

July 20, 1981
Date

William A. Nierenberg
Chairman

5-3-81
Date

Attachment 1

NASA ADVISORY COUNCIL

AGENDA

Conference Room 3201
Headquarters Bldg, KSC

APRIL 9, 1981

9:00am	Introduction	
	1. Purpose of meeting	Nierenberg
	2. Administration	Cohen
9:15am	Revised NASA Program and Guidelines Survey of basic changes and the questions raised.	Naugle
10:30am	Space and Terrestrial Applications	
	1. Space and Terrestrial Applications Committee	Firor
	2. NASA's Program Issue: Policy, program and FY83 budget questions	Calio
	3. Proposed Symposium on Remote Sensing for the Coastal Zone.	Vernberg
1:00pm	Aeronautics	
	1. NASA's Role: ASEB Workshop Recommendations and industry comments	Stever
	2. Possible research opportunity to support FAA	Loewy
	3. NAC Aeronautics Committee Assessment and concerns	Loewy
	4. NASA's Program Issue: Policy, program and FY83 budget questions	Olstad

NASA ADVISORY COUNCIL
AGENDA

APRIL 9, 1981

2:30pm	Space and Life Sciences		
	1.	Voyager Saturn Mission Accomplishments	Soderblom
	2.	Solar System Exploration Committee Assessment and concerns	Naugle
	3.	NAC Space Science Committee Assessment and concerns	Soderblom
	4.	Life Science Committee (Item Cancelled) Assessment and concerns	Dews
	5.	NASA's Program Issue: Program strategy, policy and FY83 budget questions	Stofan
3:30pm	The Space Transportation System		
	1.	The STS-1 Mission Major objectives, events, and timeline	Reilly
	2.	The Remaining Flight Test Program Criteria and missions to demonstrate operational status	Reilly
	3.	STS Manifest & Shuttle Fleet Size Issues: a. Problems from reduced program b. Need for fifth Orbiter	Lee
	4.	Spacelab Issue: The science and applications objectives and missions and the impact of the revised budget	Moore
	5.	Payload Procedures Issue: Their simplication for users	Lee
	6.	The Planned Evolution of STS Capability Issue: Goal, program and FY83 budget questions (Item Cancelled)	Bekey
	7.	NAC Space Systems and Technology Committee (Item Cancelled)	Johnsom
5:30pm	Adjourn		

NASA ADVISORY COUNCIL
AGENDA

APRIL 10, 1981 SESSION CANCELLED

1:00 pm	Computer Technology and Automation	Cameron
	1. Subcommittee on Computer Technology and Information Systems	
	2. Advanced automation for space missions Results of summer study and plans; Summer study on computer technology	Sadin
1:45 pm	NASA: History and Social Science	
	1. History Committee	Fries
	2. Social Science Task Group	Davis
2:30 pm	New Business and General Discussion	
3:00 pm	Adjourn	

Attachment 2

Space and Terrestrial Applications

The U.S. has a long and successful record of converting things learned in and about space to the practical benefit of the country and the world; for example in communications, navigation and meteorological satellites, in geodetic measurements, in land use observations and solar "weather" monitoring, as well as in hundreds of technological spinoffs. But, as in the NASA aeronautics programs, recent budget guidelines raise difficult issues concerning how far NASA should go with development and demonstration of operational systems and at what stage such work should be turned over to eventual users, both public and private. The uncertainities in the interpretation of these guidelines must be resolved at an early time.

It is clearly correct, as suggested by the new guidelines, that for NASA, entirely on its own, to undertake the creation of a number of complete, working, space applications systems neither fits with today's budget realities nor would such a process be likely to produce systems closely geared to the user's needs. But to go to the other extreme and wait for users to call for the development of specific systems fails to allow for the fact that users are frequently dispersed throughout our society and have no arrangement for taking such initiative, and in addition most users are relatively unsophisticated about the opportunities and possibilities of applying space techniques to their problems. So to procede in such a fashion would insure slow progress and would deprive the county of the benefits of making useful space applications in a timely way. Thus, criteria are needed to govern where on this spectrum the interface between NASA R&D and user control and payment should be placed.

We suggest the following:

1. NASA applications development should proceed when

a) NASA is clearly the best organization to undertake and carry forward the development, and

b) A consensus exists that the applications, when eventually deployed, has a high probability of making substantial improvements in the productivity, wealth, health, or safety of the nation.

2. The NASA development should be taken up to the point at which potential users have sufficient information to evaluate the usefulness at the techniques in pursuing their missions. This will usually mean NASA sponsored flights in which concepts are tested and proved.

3. In the special case in which the "user" is the population as a whole, as for example in the case of measurements to ascertain the amount of environmental change or damage being produced by some activity, NASA may need to conduct the total program. There are other agencies, of course, charged with environmental monitoring or protection, but these groups may find it difficult to adapt to a program which may well be more nearly an evolving set of research measurements then a fixed opperational program. In such cases, with the need for continuous development of improved space equipment, but with the nation's health, prosperity or international reputation possibly at stake, the only practical course may be for NASA to pursue the issue vigorously within its own program.

Attachment 3

Aeronautics

As the Council has said before, the NASA program in Aeronautics R&T is this nation's commitment to leadership in aviation. Currently, the United States' position of leadership is being seriously contested by nations, or consortia of nations, that are aggressively seeking and gaining major shares of the world market in this high-technology area; much as they have in steel, ship building, automobiles, and electronics. Less friendly nations, such as the U.S.S.R., are continuing to expend large resources for the development of modern weapons systems including, of course, military aircraft of all types. In spite of the obvious need to maintain, or even bolster, United States aeronautical R&T efforts at this time, the NASA budget for this activity has declined by 30 percent in purchasing power over the past two years. During this period the Space Transportation System has been exempt from significant budget reductions on valid grounds of its importance to national security and to the long-term health of an important segment of the United States economy. These same reasons should have supported NASA's Aeronautics R&T. It is the view of the NASA Advisory Council that the budget level for the Aeronautics R&T program should be protected from reduction, much as the STS is, with the policy modified, perhaps, to reflect the differing roles of U.S. industry in these two areas.

The 1980 Woods Hole workshop on the NASA role in aeronautics provided clarification and delineation of that role by a group broadly representative of the United States aviation community. The NASA Advisory Council supports the findings of the workshop and notes that these findings are as appropriate under the current Administration as under the previous Administration.

However, there are changes in philosophy that may impact the way in which NASA carries out technology demonstration and validation activities with the industry. For example, the Large Composite Primary Aircraft Structures (LCPAS) program as proposed under the previous Administration, should probably have a somewhat different character under the present Administration. The major reason for preserving that program, however, is the avowed intention of this Administration to create a climate which will stimulate private investment in R&D. The NASA investment is a pump-primer, and every bit as essential as it was a few months ago; it would appear that the success of such NASA investments in pulling industry funds - at a ratio of 3 to 1 by some estimates in the larger programs - is not widely known. More specifically, we recommend:

1. Funding for LCPAS, the Numerical Aerodynamic Simulator (NAS), and the Critical Materials programs. While classified as "new starts," each of these programs is, in fact, continuations of R&T base programs of long-term nature.

2. Advanced prop-fan research be accelerated to the point where the technology can become a realistic option for designers of both military and commercial aircraft before the end of this decade. This implies solutions beyond just aerodynamic efficiencies including structures, acoustics and vibrations.

Attachment 4

Space Science

After the enormous successes of Viking, Pioneer Venus, HEAO, and SMM, the Space Science program faces a hiatus of new starts and continued loss of vitality. We are relieved to see that the Gamma Ray Observatory (GRO) and the proposed new start on the Venus Orbiting Imaging Radar (VOIR) are delayed and not cancelled. These projects promise significant scientific achievements, and the scientific community agrees that these are the wisest investment of limited funds at this time. Survival of our national space exploration program mandates that these projects be fully funded in next year's budget and in subsequent years to assure that earliest flight opportunity.

The NAC expresses its profound dismay over the drastic reduction in the U.S. participation in the international Solar Polar Mission (ISPM). This reduction has resulted in a cancellation of the U.S. spacecraft in this joint two-spacecraft mission with the European Space Agency. ISPM is an integral part of the Nation's effort to study the Sun and its influence on Earth. It is the first comprehensive effort to study the global properties of the Sun and its surrounding region - the heliosphere - in regions away from the ecliptic plane. Although one spacecraft could perform the first reconnaissance of the heliosphere in its third dimension, two spacecraft are essential to measure conditions simultaneously in the northern and southern solar hemispheres, permitting separation of spatial and temporal effects and thus permitting determination of the dynamics, time variations, and three-dimensional configuration of the heliosphere.

Established and orderly procedures were followed in planning ISPM and in obtaining Congressional approval; the mission is now three years into its implementation phase. Cancellation of a mission advanced to this stage is unprecedented. It will undermine the strength and credibility of NASA's careful planning process, and the value of NASA's commitments to the U.S.-scientific community and to the U.S. high technology industries which have been the backbone of the Nation's space effort. Furthermore, cancellation of the U.S. spacecraft is an abridgement of the U.S.'s commitments to ESA and its member states, thereby undermining the credibility of NASA's commitment to cooperative programs with foreign governments and international institutions in all its areas of endeavor.

The NAC reaffirms that a two-spacecraft reconnaissance of the three-dimensional properties of the Sun and the heliosphere remains one of the highest priority science missions. The NAC urges NASA to make every effort to preserve as much of the U.S. participation in ISPM, and the two-spacecraft concept, as is feasible. The NAC is profoundly concerned that to do otherwise will result in a serious setback to solar-terrestrial research in the U.S.

The NAC reaffirms that the Galileo mission to Jupiter and the earth-orbiting Space Telescope are critical items of the highest priority within the Space Science program. These two broadly conceived missions will be of immense value in the exploration of our universe. These two missions should be pursued to completion without further delay; any delays would almost certainly result in major cost growth and might even raise the prospect of their cancellation. Cancellation of either one of these programs would have a catastrophic impact upon the Space Science program.

Galileo has already experienced serious slips caused by delays in the Shuttle and Shuttle upper stage readiness. It is now clear that the most viable solution to the Galileo launch problem and the only one which can keep it on track for a 1985 launch, is to proceed with the Shuttle-Centaur development. It is clearly the best understood option with virtually guaranteed technical success. The principal hurdles that remain seem to be political. The NAC urges that the Agency proceed to bring the Shuttle-Centaur into existence on a schedule which will support a 1985 launch for Galileo. In addition, availability of this launch capability will have far-reaching consequences for the future of our National solar system exploration program. A broad program of solar system exploration from now until the end of the century will demand a performance similar to the Shuttle-Centaur. The disappearance of the Titan-Centaur has resulted in an unfortunate hiatus in our exploration of the solar system in the first half of the decade of the eighties. This situation must be avoided in the future. Existence of the Shuttle-Centaur capability will be a key component in the revitalization of our deep-space exploration program in the second half of the decade.

Finally, we note that there are many new opportunities that are already evident in space astronomy, solar and space physics, and solar system exploration. We are deeply disturbed by the implications of future budget constraints for the long-term, well-being of the Space Science program and for the health of the government/university/industry research, engineering and management teams who are so vital in assuring that the Country's scientific and technological leadership will be maintained.

October 12, 1981

SUMMARY MINUTES OF THE
NASA ADVISORY COUNCIL
AUGUST 3-4, 1981
SCRIPPS INSTITUTION OF OCEANOGRAPHY
LA JOLLA, CALIFORNIA

I. Attendees:

Chairman:	William A. Nierenberg
Members Present:	A.G.W. Cameron Morris Cohen Kingsley Davis Willis M. Hawkins Robert L. Johnson Elliott Levinthal (4th only) Robert G. Loewy James A. Michener James W. Plummer Laurence A. Soderblom Richard J. Wurtman (3rd only)
Members Absent:	Randolph W. Bromery Sylvia D. Fries James N. Lew John E. Naugle Robert W. Rummel Clifford V. Smith Winona B. Vernberg
Execu ive Secretary:	Nathaniel B. Cohen
Assistant Executive Secretary:	Carl R. Praktish
NASA Headquarters Personnel:	Ivan Bekey Anthony J. Calio Richard F. Carlisle Jack L. Kerrebrock William P. Raney Andrew J. Stofan
Visitors and Affiliation:	Will Botzong - RCA (4th only) Morgan Sanborn - Rockwell

II. Agenda

The Agenda is attached. Last minute changes showing adjustments permitting all items to be completed and the meeting to be adjourned on August 4 are noted on the agenda. The presentation material on file includes:

Items	Description
1.	Presentation on Space Science by Andrew J. Stofan - 13 charts
2.	SSAC Recommendations on FY 1983 Critical Issues, Laurence A. Soderblom, 12 pages, with cover letter, dated August 3, 1981
3.	Committee Summary on Life Sciences - 2 pages
4.	Presentation by Jack Kerrebrock on NASA's strategy and program concepts on Aeronautics - 13 charts
5.	Presentation by R.G. Loewy on Aeronautics Advisory Committee - 19 charts
6.	Presentation by Jack Kerrebrock on Space Research and Technology - 17 charts
7.	Committee Summary on Space Technology and Energy - 2 pages
8.	Presentation by Anthony Calio on Applications for the Future - 6 pages
9.	Presentation by Ivan Bekey on Space Platforms and Space Stations, dated August 4, 1981 - 32 charts
10.	Presentation by R.F. Carlisle on Space Technology Aspects, Space Platforms/Space Stations, dated August 4, 1981 - 30 charts
11.	Proposed Orbital Activities Study - 1 chart
12.	Presentation on Goals Study - 4 charts

III. Introduction

At this meeting, the Council focused its attention on NASA's planning, both for the FY 1983 budget and near-term programs and for the longer-range future. Representing the Administrator, the Associate Administrator for Space and Terrestrial Applications noted senior management's commitments:

- to making Shuttle an efficient operational success and to controlling cost escalation.
- to developing a strong aeronautics and civil space program
- to establishing a policy that permits appropriate technology development/demonstration projects.

The initiation by the new Administration of a study of space policy and the opportunities that study may present relative to previous space policy were noted. The Council then turned its attention to the main agenda items, namely:

- the program office's near term strategies and the associated committee reports
- the planning process for future earth orbital activities including space platforms/stations
- the study of possible longer-term goals for NASA.

ACTION - Executive Secretary, to distribute to the Council members, for background, copies of the Presidential Directives on National Space Policy of the previous Administration .....Done.

IV. Program Office Near-Term Strategies and Concepts

A. Space and Life Sciences

1. The Program Office's Strategy

The Acting Associate Administrator began by noting the principal near-term issues in the space sciences:

a. Options for the International Solar Polar Mission (ISPM). Restoration of a second space craft would require additional funding totalling from about $100 million to about $300 million, depending upon option, with imaging capability (as included in the original U.S. spacecraft) requiring the larger amounts. Although it is the most expensive option, there is a strong preference for restoration of the original U.S. spacecraft based on total program effectiveness and science return. The issues and options were studied recently by the National Research Council/Assembly of Engineering's Committee on NASA Program Changes - ISPM Review Panel.*

b. Whither space science? The Space Science program funding "roller coaster" since 1964 makes orderly planning difficult and the continual downward trend has resulted in plans always considerably in excess of what is finally approved. The program has reached the point where its continued viability must be questioned. Reconstructing a strong, productive Space Science program requires both adequate funds and funding stability.

*The National Research Council reported the Panel's findings to the Chairman of the House Appropriations Subcommittee on HUD and Independent Agencies via a transmittal letter dated September 9, 1981, and its attached report. In short, the Panel stated that, on the basis of scientific merit and relative to a one (European) spacecraft mission, the benefit-to-cost ratio of adding a second spacecraft of limited capability was less than that of going to full restoration of the U.S. spacecraft.

c. The future of Galileo. Availability of the Wide Body Centaur and tradeoffs with launch date (1985 vs. 1987) must be resolved.

d. Possible missions to Halley's Comet. A go/no decision is required shortly.

For the longer term, specific issues include:

e. Future projects to maintain U.S. progress in X-ray astronomy

f. The future of solar system exploration -- and the related issues of high-energy stage (Centaur, Inertial Upper Stage, Solar Electric Propulsion System) availability

g. Utilization of Shuttle/Spacelab

h. Maintenance of an institutional and technological base

i. Large vs. more modest flight projects

In the areas of life sciences, the issues are:

j. Trade-offs among the medical program in support of Shuttle and the wide range of life science research programs under conditions of limited funding.

k. Maximizing use of Spacelabs for life science research, given its capabilities and the constraints on its use.

2. Space Science Advisory Committee Report

The Committee Chairman said the fundamental issue is whether funds would be available to maintain the space science program if national economic policy requires continued budget constraints and if Shuttle costs continue to escalate. Last year saw major delays and reductions in each area of the program and the unprecendented cancellation of a congressionally-approved joint program. NASA no longer faces only delays and program reductions but the possible termination of entire major elements of its program.

Regarding its view of the most critical issues, the committee believes that the ongoing program must be protected against further reductions. It reaffirms its support of Galileo, the Space Telesco- Venus Orbiting Imaging Rader (VOIR) and Gamma Ray Observatory (GRO).

In addition, it gives highest priority to:

a. Proceeding with the development of the Shuttle-launched Centaur to meet the 1985 Galileo launch.

b. Reinstatement of the U.S. ISPM spacecraft in the original configuration.

93-418 O—82——99

c. Augmenting the Explorer program to $80-100 million a year

d. Proceeding with a mission to Halley's Comet if at all possible.

3. Council Discussion

The Chairman of the Space Science Board noted that NASA's 10-year plan had now become a 20-year plan because of funding constraints. The Board agrees fully with the protection of Galileo, the Space Telescope, VOIR, and GRO because they represent first priority science. The Board would endorse a Halley Earth Return (HER) mission to collect cometary debris; it, too, is considered first priority science. The Halley Intercept Mission (HIM) is of lower priority; it is endorsed but not at the cost of first priority projects. The Halley Earth Mission (THEM) is also acceptable but is of high cost.

4. Life Sciences Advisory Committee Report

The Committee was represented by its past Chairman, who began by noting that the program is urgent if NASA is to remain in the manned space flight business because NASA needs to understand and model possible problem areas involving men in space and to develop countermeasures. Problem areas in operational medicine include cardiovascular, vestibular, bone and muscle mass, and factors affecting optimal performance in space. There is also the need for additional research in such areas as the effects of weightlessness for long durations and for development of technologies for closed ecological systems and other support systems such as space suits.

The Committee believes it important that the Council affirm its support of the broad range of life science research including that on the effects of the space environment on humans, on basic biological processes, and on life support technologies, as well as on operational medicine.

B. Aeronautics

1. Program Office Strategy

The Associate Administrator for Aeronautics and Space Technology stated the basic premise for the program as maintaining national preeminence in aeronautics, and said the central issue is the government/NASA role in achieving this goal. His program strategy is to:

a. Increase the fundamental research and technology efforts in areas critical to the future, such as:

- aerodynamics of high performance military aircraft

- advanced composite materials

b. Enhance NASA computational and facilities capabilities, such as:

- Numerical Aerodynamics Simulator, which would advance the capability to model mathematically from first principles in such areas as three-dimensional viscous flows, dynamic aerodynamic/aeroelastic loads, and complex atmospheric and chemical processes

- Improvement of facility productivity, which would produce data more effectively and reduce the waiting time for access to wind tunnels

c. Initiate or augment efforts towards systems technologies which offer high payoffs areas for military and industrial applications

- transport aircraft composite structures, which focuses on the fabrication and test of primary as well as secondary structures

- advanced turboprop technology, which promises significant improvement in fuel efficiency over turbofans.

- small engine technology, for commuter and general aviation aircraft and rotorcraft

- quiet efficient rotorcraft technology, to meet impending noise regulations while maintaining market potential.

2. Aeronautics Advisory Committee Report

The Chairman noted that the Committee agreed with the program strategy of NASA and provided the following recommendations:

a. The Committee endorsed

- NASA's emphasis on preserving unique expertise and facilities

- NASA's emphasis on building the research and technology base

- continued drive toward energy efficiency

- continued support of DOD through unique capabilities, and

- the report resulting from the Summer 1980 Workshop conducted by the Aeronautics and Space Engineering Board at Woods Hole on NASA's role in Aeronautics

b. The Committee recommended that NASA exploit the computer-base technology explosion, e.g.,

- in computational fluid mechanics, computer-assisted design and manufacturing, and integrated digital flight and engine controls

- but balanced with sufficient corroborative experiments, from laboratory to wind tunnel to flight test

c. The Committee noted that flight tests of systems through the technology development/validation mode are necessary to realize synergistic gains and discover and overcome unanticipated interactions. Both are often only revealed in full scale flight tests of complete systems and under realistic conditions. To get at the basics in many instances requires full investigation of applications. It recommended that NASA pursue development/validation activities when appropriate.

3. Council Discussion

The Council agreed with the recommendations of the Committee and decided to include in its recommendations to NASA special emphasis on the importance of NASA's role to National preeminence, the need to increase aeronautical program priority (and hence funding), and the importance of NASA's conduct of appropriate technology demonstration/validation projects.

C. Space Technology and Energy

1. Program Office Strategy

The Associate Administrator for Aeronautics and Space Technology stated the primary program goal is to assure the maintenance of a strong technology base in support of retaining U.S. space leadership. Program strategy is directed towards achieving technology readiness for imaginative, affordable missions for the 1990s through:

a. Restoring an adequate and balanced disciplinary technology base

b. Expanding the base to include necessary systems technology programs

c. Conducting complete systems technology readiness demonstrations to that level required for transfer to flight projects.

While the disciplinary technology base has been strengthened, expansion of the systems technology program and conduct of technology demonstrations have been reduced under budgetary pressure. Candidate systems technology projects are the technology payloads experiment, entry research test, and large antenna flight experiment. The FY 1983 program will propose expanded activities in some of these areas.

In energy technology, the program is being restructured to place emphasis on research and technology closely aligned to their aerospace counterparts, and to give NASA technical management control of programs undertaken for other agencies. Coordination with the Department of Energy (DOE) is underway.

2. Space Systems and Technology Advisory Committee Report

The Chairman noted the Committee's endorsement of the priority given to restoring the technology base. The emphasis on affordability is sound and reflects the historic evolution of emphasis from performance to affordability. The area that needs to be strengthened is the process for transferring technology into mission office flight programs. The Committee suggests that users should be required to employ relevant new technologies demonstrated by flight experiment, but should be given a backup should the new technology fail.

The Committee also noted the need to continue liquid rocket research (in the light of performance and environmental shortcomings of solid rockets) and to proceed more vigorously in the area of automation.

Finally, on energy technology, the Committee recommended:

a. NASA should not choose to phase out of energy work if it can be of value to the country via NASA support to the DOE. NASA should seek to carry out specific energy activities that utilize its expertise to accomplish technical advancements in programs that provide NASA with appropriate responsibilities and authority.

b. NASA management should meet as soon as possible with DOE to clarify roles.

3. Council Discussion

The Council concurred with the Committee's position regarding the accomplished increase in the research and technology base and the needs for systems technology programs, but noted that the need for technology demonstration projects and the transfer of demonstrated technologies to the mission users needs more attention.

D. Space and Terrestrial Applications

1. Program Office Strategy

The Associate Administrator for Space and Terrestrial Applications noted that the program strategy is changing in response to new elements in the Administration's R&D policy. As in Aeronautics, the Administration's policy as inferred by budget decisions, is one which tends to take the Federal Government out of part of R&D -- the demonstration of systems part -- which would benefit the private sector. In areas which are the responsibility of the

Federal Government (e.g., meteorology, ocean and land remote sensing), operational programs should be conducted by the responsible agency (e.g., NOAA), not by NASA. The key elements of the present program strategy are:

a. Opportunities for space applications are many, but the rising costs of missions and increasingly constrained budgets mean that specific program areas may simply have to be abandoned in order to maintain viable research and development programs in the most important areas

b. Joint programs with Federal agencies tend to be vulnerable and will be minimized. Joint endeavors with industry offer opportunities for demonstration of important new technologies and will be increasingly sought.

c. The program will make effective use of the Shuttle where possible, but the need for free flyers must be recognized as necessary in many program areas.

In line with the foregoing strategy, in the areas of atmospheric remote sensing, NASA has the responsibility for R&D in new instrumentation and advanced systems in all atmospheric fields (i.e., meteorology, upper atmosphere, and climate research). NOAA has operational responsibility in meteorology, and reimburses NASA for development and launch of operational systems. Although the national interest would be best served by continuation of this policy, if NASA's R&D is further reduced, NASA would remain in upper atmosphere and climate research and leave the meteorology research to NOAA.

In ocean emote sensing programs, NOSS has been cancelled and the focus is now on research, such as the Topography Experiment. However, if there are further budget reductions, even the ocean research programs would likely be cancelled. In the area of land programs, further reduction in research funding would threaten AgRISTARS, the Caribbean plate observations, and gravity field measurements.

With the impending saturation of UHF communications frequencies, there is need to develop the technology for Ka band (30/20 GHz) satellite communication. Other countries, recognizing the market, are moving aggressively to develop the technology that users will need in a few years. NASA must begin its flight demonstration program no later than Fiscal Year 1984 if the U.S. is to be a competitor. Industry cannot undertake the necessary flight test program to resolve the uncertainties involved in total systems operations in an erratic environment (especially attenuation of signal through rain) because no one U.S. company could afford the necessary flight test program and a consortium would be prohibited from doing this by antitrust laws.

In response to 1978 recommendations of the Committee on Scientific and Technological Aspects of Materials Processing in Space (STAMPS) of the National Research Council, NASA's materials processing program has developed a strong science base with emphasis on processing science, rather than on narrow treatment of individual materials. The program now also stresses the importance of a strong terrestrial basis for any space processing studies to be considered. The STAMPS committee has recently reviewed the current program and concluded that NASA has responded very well to their earlier recommendations, and that the program is now appropriately broadly based and addresses real issues in materials science and technology.

2. Council Discussion

The Chairman of the Space Applications Board stated the Board's strong support for the programs, particularly in communications, where big payoffs have already been demonstrated, and in remote sensing, which is so close to demonstrating payoff of equal significance. NASA is the most logical organization to take the lead and move ahead in these areas.

The Council concurred with the main elements of NASA's program strategy and plan and noted that the role of the Federal government and that of NASA in these space applications was analogous to those roles in aeronautics. Similar criteria could be established to define when there should be such involvement. These points should be emphasized in the Council's report to NASA.

E. Council's Deliberations and Actions

1. The Council generally endorsed the program strategies of NASA and the associated committee reports. They decided that the Council report should emphasize:

a. Support for making the Shuttle operational, coupled with its concern for the budgetary impact on other programs.

b. Continuation, with no further delay, of the ongoing Space and Life Sciences programs, restoration of the ISPM, an increase in the Explorer budget, and, if possible, initiation of a meaningful mission to Halley's Comet.

c. Support for the national policy of preeminence in aeronautics, NASA's role as described in the 1980 ASEB Report, and the need for conduct of technology demonstration and validation projects.

d. Strong support for the 30/20-GHz flight test program and those remote sensing programs near the point of significant payoff; equally strong support for maintaining a significant NASA role even to include flight demonstration, where appropriate.

2. Given concern about constrained budgets coupled with rising, Shuttle costs, the Council asked that criteria be developed for helping the Administrator in his program decisions.

3. The Council reiterated its willingness to send a delegation to the OMB Director to present its views on the importance of national preeminence in aeronautics and of maintaining NASA's role and programs.

ACTIONS

- Executive Secretary, to draft a Council report to these specifications for Council review and eventual presentation to the Administrator .....Done

- Executive Secretary, to schedule an early Council meeting for discussion of this report with the Administrator. The agenda should include:

  o NASA status report on Shuttle, with emphasis on problems in achieving operational success.

  o NASA Advisory Council report on outcome of August 3-4 meeting -- near-term program recommendations, recommendations for orbital activity study, and recommendation of "Goals Study." .....Done

V. Major Question: Where do we go in earth orbital activities?

A. Potential Space Science Requirements

The Acting Associate Adminstrator for Space Science described the orbital science program as one which will make best use of the complementary capabilities of Shuttle/Spacelab, free flyers, suborbital (rocket, balloon, airplane) platforms, and space platforms. The Science and Applications Space Platform would provide extended on-orbit stay times beyond the Shuttle's capability, while making full use of Shuttle's capability for transportation, payload servicing, and changeout as needed. Clustering payloads around common housekeeping systems provides economies not available with free flyers. He then cited a number of candidate payloads such as the Solar Optical Telescope. He also noted the eventual requirement for man-tending of life science experiments.

B. Potential Applications Requirements

The Assistant Associate Administrator for Space and Terrestrial Applications said that the program would be structured to gain experience with both manned and automated systems in order to decide what options to keep open. For example, materials processing experiments could require man-tending to begin with, but the experiment service functions might be automated in time. Platforms could be useful to fly a variety of instruments as part of a total system so that unknowns that cannot be resolved on the ground could be worked out. However, decisions will have to be made on what systems can fly on the same platform (i.e., same orbit, same time period, compatible services and environments) before real hard needs can be established. One possible requirement that stands out is materials processing, where high power

requirements seem to fit well platform capabilities. But the materials processing program itself needs to be worked out in more detail before plans for that eventuality can be developed.

C. NASA's Planning Studies: Space Platforms and Space Stations

The Director of Advanced Programs, Office of Space Transportation Systems, proposed the following goal: "by end of century, emplace space-based assets and infrastructure to allow large scale space utilization on a broad front." This translates into permanent occupancy in low orbit by 1990 and in geostationary orbit by 2000, which, in turn, requires the development of the ability to provide more economical payload support, to build and repair in space, to operate long duration manned facilities, and to provide more economical transportation.

The first step would be an unmanned platform, which would provide more economical payload support and require fewer Shuttle missions than would the equivalent payloads comprised of free flyers. The follow-on steps would include additional platforms having increased capability and placed in appropriately different low orbits, geostationary platforms, and eventually a manned low orbit space station. A list of candidate platform payloads was then presented. An unmanned platform project is a candidate new start for Fiscal Year 1983. While planning for the configuration of a geostationary platform is not as advanced, there is a clear need for such a capability -- communications is the prime example. Such a program would begin with a demonstration of uses as well as needed technologies and culminate in first an experimental platform and then operational platforms of various capabilities.

Concepts for manned space stations have been studied extensively over the past fifteen years at a cost totaling about $40 million. Therefore, the issue now is less a need for more detailed design than a mission identification and justification for proceeding with specific planning leading eventually to hardware development. One scenario for the evolution of space station functions would begin with a manned operations base providing first orbital services in low earth orbit, then support for high energy missions, and finally support for space construction. An alternative scenario begins with an unmanned platform to provide support for science, applications, and industrial process/product development programs, and later grows to include manned capability.

The question remains of how to integrate these options into a viable plan. A strawman that begins with an unmanned platform in the late 1980s and grows to manned capability development for both operations and research activities in the early 1990s was proposed. The key element, a manned space station, would be initiated in FY 1985, and would lead to a "capability utilization" phase in the 1995 time frame. The operations capability would be used for low Earth orbit system servicing, staging high energy missions, supporting geostationary orbit activities, and constructing large structures. The research capability would be used for zero gravity and vacuum research as well as pilot commercial ventures. The last steps, in the 2000 time frame, would expend the low orbit capabilities for large scale industrial operations and would provide geostationary orbit capability.

D. Space Technology Aspects

The Spacecraft Systems Chief, Office of Aeronautics and Space Technology (OAST), said technology requirements for both the space platform and Space Operations Center (SOC) have been assessed and he provided an evaluation of each subsystem.

In the case of the space platform, most of the basic technology is proven and questions remain only in the areas of structures, thermal systems, and space operations. The technology risk is less than 5 percent of the estimated program cost and a new start in FY 1983 is feasible. However, because the technology is old, it is not recommended for use beyond the first platform. The technology for a second generation platform would be available in 1987, according to their current plan.

In the case of SOC, there are technology questions in each of the subsystem areas. The options for reducing the technological uncertainties include (a) reducing the scope of the initial SOC, (b) increasing the spending rate to develop the necessary technology, or (c) accepting some technology development in parellel with other program activities. OAST recommends an enhanced technology program so that SOC could be started as proposed (FY 1985).

E. Council's Deliberations and Actions

The Council is pleased at the elements of planning to date, but recognizes the need for further thorough planning if agency decision makers are to have all the data they need when it is a time to choose a course of action. Particularly important is a logical and rational program plan that best integrates the many pieces under consideration, is most consistent with the evolution of present capabilities, and strives towards program goals most effectively. Therefore, the Council agreed to propose to the Administrator establishment of an ad hoc committee to study the evolving planning on potential requirements and program options and to prepare for the Council a critique of present planning and recommendations for NASA action. The report should also recommend on the advisability of further committee work, including its possible formalization as a "permanent" standing committee.

ACTION: - Hawkins, Levinthal, and Naugle, to draft a paper representing "Terms of Reference" for the proposed study for consideration by the Council and proposal to NASA .....Done

VI. Goals Study

A. Proposal Approach

The Council chairman proposed that the Council endorse resumption of the Goals Study if the Administrator agreed. The purpose would be to conduct a scholarly study of the advisability, feasibility, and implications of these candidate goals:

1. To achieve the capability to enable future generations to establish self sustaining human habitations in space when they should decide to do so

2. To understand the present human habitat as a total biogeochemical system, and develop the space systems required to predict its behavior, protect it from natural or man made catastrophes, and use extra-terrestrial resources to help meet its needs.

The Steering Committee for the Study had earlier agreed that the following would need to be understood by decision makers:

1. The rational for the goal including why it is important to pursue this goal at this time

2. The logical schedule of events or major projects that would be needed to provide the capability required by the goal

3. The relevant, current, and planned programs

4. The required research and technology development

5. The interagency and international implications including the role of other agencies

6. The financial implications

7. The strategy for establishing the goal

The plan was that a small study group would be established for each goal and would prepare papers on these subjects. Their activities would be led by The Steering Committee, which would compile a final report to the Council and NASA. The Steering Committee would remain as originally constituted except for members whose terms on the Council had ended.

The schedule for the study was also discussed.

B. Council's Deliberations and Actions

The Council members agreed that the study was still needed in order to help NASA in identifying long-term goals towards which it should be planning its future programs. The study would in no way constitute commitment to projects. The benefits of the study could be adoption of those goals, identification of other goals worthy of study, and a better understanding of how current decisions could keep open (or close) options for the future.

ACTION - Naugle, to prepare a summary of study status at the time of postponement, and to prepare a Council proposal for study resumption. .....Done

VII. Computer Studies

The Chairman of the Advisory Subcommittee on Computer Technology and Information Systems reported briefly on the status of the subcommittee's study. To acquire a reasonably representative sample for review, the group is surveying all computer and information systems activities at one field installation having a significant activity (Goddard Space Flight Center) and a cross cut through all field installations of one technology (image processing). Fact-finding has not been carried far enough for any conclusions to be drawn at this time.

In discussion, Council members reiterated their concern that the study address not only NASA's position with respect to the state of the art in its own use of computer and information systems technology (i.e., tools), but in integrating these technologies into the systems technologies that represent the products of its R&D efforts.

VIII. Executive Session

The Council held a brief executive session for discussion of membership status and issues.

Nathaniel B. Cohen
Executive Secretary

10/13/81
Date

William A. Nierenberg
Chairman

10-13-81
Date

Attachment 1 August 3, 1981

NASA Advisory Council
August 3-5

Agenda

August 3

8:30	Introduction: Meeting Plan and Administrative Details - Nierenberg/Cohen
8:45	Administrator's Overview - Beggs
9:00	Space and Life Science
	1. NASA's strategy and program concepts - Stofan
	2. Space Science Advisory Committee: evaluation/ recommendations - Soderblom
	3. Development of Council's recommendations - Soderblom
	4. Life Sciences Advisory Committee: evaluation/ recommendations - Wurtman
	5. Development of Council's recommendations - Wurtman
11:45	Lunch
12:30	Aeronautics
	1. NASA's strategy and program concepts - Kerrebrock
	2. Aeronautics Advisory Committee: evaluation/ recommendations - Loewy
	3. Development of Council's recommendations - Loewy
2:30	Break
3:00	Space Technology and Energy
	1. NASA's strategy and program concepts - Kerrebrock
	2. Space Systems and Technology Advisory Committee: evaluation/recommendations - Johnson
	3. Development of Council's recommendations - Johnson
4:30	Computer Studies - Cameron
5:00	Adjourn
7:00	DINNER

August 4

8:00	Space and Terrestrial Applications
	1. NASA's strategy and program concepts - Calio
	2. Development of Council's recommendations - Calio
10:00	Break
10:30	Administrator's Comments - Beggs
11:00	Wrap Up Session
	Discussion and final preparation of Council's recommendations - Nierenberg
11:45	Lunch
12:30	Major Question: Where do we go in earth orbital activities?
	1. Potential requirements: space and life sciences; applications - Stofan/Calio
	2. NASA's planning studies: the options of space platforms and space stations - Bekey
	3. Space Technology aspects - Kerrebrock
	4. Council discussion - Nierenberg
~~5:00~~	~~Adjourn~~

~~August 5~~

4:00	
~~8:00~~	Plan for Resumption of Goals Study - Nierenberg
~~9:00~~	~~Computer Studies - Cameron~~
4:30	
~~9:30~~	Closed Session
	Membership Issues - Nierenberg
5:00	
~~10:00~~	Adjourn ~~(tentative)~~

SUMMARY MINUTES OF THE
NASA ADVISORY COUNCIL
SEPTEMBER 30, 1981
NASA HEADQUARTERS
WASHINGTON, DC

I. Attendees:

Chairman: William A. Nierenberg

Members:

A.G.W. Cameron
Morris Cohen
Peter Dews
Sylvia D. Fries
Willis M. Hawkins
James N. Lew
Elliott Levinthal
Robert G. Loewy
James A. Michener
John E. Naugle
James W. Plummer
Laurence A. Soderblom

Staff:

Nathaniel B. Cohen
Carl R. Praktish
Jane E. Scott

NASA HQ. Personnel:

James M. Beggs
Ivan Bekey
Geoffrey A. Briggs
Anthony J. Calio
Philip E. Culbertson
Jack L. Kerrebrock
Hans Mark
William P. Raney
Jeffrey D. Rosendhal
Uldis J. Sakss
Gerald A. Soffen
Andrew J. Stofan
L. Michael Weeks
Stanley I. Weiss

Visitors:

Don Brennan, RCA
Newton W. Cunningham, Hughes Aircraft
Murray Felsher, Washington Remote Sensing Letter
J. P. Fouquet, Embassy of France
Noel Hinners, Smithsonian Institution (Presentation)
W. J. Mellors, European Space Agency
R. W. Riebling, Staff of Senator Thurmond
Ted Simpson, U. S. Senate Staff
Clotaire Woods, National Research Council

II. Members Absent:

Randolph W. Bromery
Kingsley Davis
Robert L. Johnson
Robert W. Rummel
Clifford V. Smith
Adlai E. Stevenson
Winona B. Vernberg

III. Agenda:

The agendas are attached. The presentation material on file includes:

Item	Description
1.	Solar System Exploration Committee Status Report..... 26 Charts
2.	NASA Advisory Council Report to NASA on FY 1983 Long-Range Planning; Summary..... 6 Charts
3.	NAC Aeronautics Advisory Committee Report..... 19 Charts
4.	NAC Space Science Advisory Committee Report..... 8 Charts
5.	Additional NAC and Committee Comments and Recommendations..... 2 Charts
6.	Proposal to Resume Goals Study and Initiate Study of NASA Planning for Orbital Activities..... 13 Charts

IV. Meeting Highlights

The morning session began with a status report from the Solar System Exploration Committee and then focused on a review of the Council's reports to be presented to the Administrator and Deputy Administrator in the afternoon. At the afternoon session, the report on NASA's Fiscal Year 1983 long-range planning was presented by the Council Chairman, and was augmented by more detailed briefings by the Chairmen of the Aeronautics and Space Science Advisory Committees on their respective program recommendations. The Council Chairman summarized the recommendations from the other committees, with added commentary provided by the Acting Chairman, Life Sciences Advisory Committee. Council member John Naugle presented the NASA Advisory Council proposal to resume the Goals Study and to begin a review of NASA's planning for long-duration orbital activities. These proposals were approved by the Administrator.

V. Solar System Exploration Committee

Noel Hinners, Director of the National Air and Space Museum, Smithsonian Institution, summarized the reasons for this committee, its charter and composition, and the activities, both past and future. The committee's charter is to "translate the scientific strategy

developed by the NASA Space Science Board into a realistic, technically sound sequence of missions consistent with that strategy and with resources expected to be available....." This committee's interim recommendation focused on the importance of continuing Galileo and Venus Orbiting Imaging Radar missions, considering a Halley Intercept Mission (but not at the expense of projects presently in the FY 1982 program), and developing a high energy upper-stage to enable the conduct of critical missions throughout the next two decades. The report also expressed the committee's concern over the cancellation of the U. S. spacecraft for the International Solar Polar Mission. Dr. Hinners, who has agreed to chair the committee for the coming year, described the options for solar sytem exploration to be considered during the balance of the study, including approaches to reducing cost and increasing efficiency.

VI. Report on NASA's FY 1983 Long-Range Planning

The report was presented by the Council Chairman, with program-specific recommendations added by appropriate committee chairmen. The substance of the report is contained in the final minutes of the NAC meeting of August 3-4, 1981 (dated October 12, 1981), and in the written "Report to the NASA Administrator on Fiscal Year 1983 Long-Range Planning," dated October 1, 1981, and transmitted by the Chairman's letter of October 9, 1981.

In the morning session, comparatively minor editorial changes were made on the final draft written report and on the proposed briefing charts for the oral report. The oral report was presented to the NASA Administrator in the afternoon. During discussion, the Administrator stated the need for a more convincing rationale for justifying technology demonstration and validation projects, both in Aeronautics and in Space and Terrestrial Applications.

Actions - Executive Secretary, to incorporate the necessary changes in the written final report and prepare it for transmittal from the Chairman to the Administrator ..... Done

- Council, to consider ways to improve the rationale for justification of NASA conduct of critical technology demonstration and validation projects ..... Under Consideration

VII. NASA Advisory Council Proposal to Conduct Two Studies

At the August 3-4, 1981, meeting (see the minutes), the Council agreed to propose to the Administrator that it (1) resume the study of long-range space goals, initiated a year ago but deferred during the change in administration, and (2) conduct a study of NASA's planning for long-duration orbital activities. These proposals were contained in a briefing delivered by Council member John Naugle, who would serve as Vice Chairman and General Manager of the first study group and Chairman of the second study group.

A. Goals Study

The Goals Study would focus on two candidate long-range goals:

- to achieve the capability to enable future generations to establish self-sustaining human habitations in space when they should decide to do so

- to understand the present human habitat as a total bio-geochemical system and to develop the space systems required to predict its behavior, protect it from natural or man-made catastrophes, and use extraterrestrial resources to help meet its needs.

The proposal is to establish a small study group for each goal (under the overall direction of a Council steering group). Each group would investigate the issues associated with adopting that goal (e.g., rationale for goal, logical program schedule and sequence, required research and technology, socioeconomic considerations). Their reports would be submitted to the steering group and then to the Council.

B. Evaluation of NASA's Planning for Orbital Activities

The review of NASA's planning for earth orbital activities would "determine if the necessary information and technical options are being developed to enable a rational decision to be made on the proper use of free flyers, Spacelab, space platforms, and a Space Operations Center." The review would be done over the next year by a committee of the Council to be selected.

The Administrator indicated his approval of the conduct of both studies as described.

Actions - Executive secretary, to prepare, for NASA approval, the necessary documents establishing both study groups, to develop refined estimates of study costs, and to arrange for the funds to be made available ..... Done

- John Naugle, to get both study groups organized and the studies underway ..... Working

Nathaniel B. Cohen — 11/30/81
Nathaniel B. Cohen
Executive Secretary

William A. Nierenberg — December 10, 1981
William A. Nierenberg
Chairman, NAC

9/24/81

NASA ADVISORY COUNCIL
September 30, 1981

Meeting Agenda

Location: NASA Headquarters
Room 7002, 400 Maryland Avenue, SW
Washington, DC 20546

Time	Agenda Item	
9:00 a.m.	Introduction	Nierenberg/Cohen
9:15 a.m.	Status Report from Solar System Exploration Committee	Hinners
9:45 a.m.	Discussion of NASA Advisory Council Report on NASA Planning	Nierenberg, et al
11:15 a.m.	Discussion of NASA Advisory Council Proposals for Studies	Nierenberg/Naugle
12:00 noon	Lunch	
1:00 p.m.	Report of NASA Advisory Council on NASA Planning	Nierenberg, et al
2:45 p.m.	Proposal by NASA Advisory Council to Conduct Studies	Nierenberg/Naugle
3:30 p.m.	Adjourn	

9/24/81

NASA ADVISORY COUNCIL

DETAILED AGENDA/MEETING PLAN
MORNING SESSION - SEPTEMBER 30, 1981

Time	Agenda Item
9:00 a.m.	Introduction - Welcome to members - Notes on Agenda and Plan ..... Nierenberg
	- Administrative Matters ..... Cohen
9:15 a.m.	Status Report from Solar System Exploration Committee ..... Hinners
9:45 a.m.	Discussion of NASA Advisory Council Report on NASA Planning
(9:45 a.m.)	- Discussion of "Final Draft" Written Report ..... Cohen
(10:00 a.m.)	- Review of Briefing Charts for NAC Report ..... Nierenberg
(10:20 a.m.)	- Review of Briefing Charts for Aeronautics Advisory Committee Report ..... Loewy
(10:40 a.m.)	- Review of Briefing Charts for Space Science Advisory Committee Report ..... Soderblom
(11:00 a.m.)	- Review of Briefing Charts for Other Committee Reports ..... Nierenberg
11:15 a.m.	Discussion of NASA Advisory Council Proposals for Studies
(11:15 a.m.)	- Review of Briefing Charts on Proposal to Resume Goals Study ..... Nierenberg/Naugle
(11:35 a.m.)	- Review of Briefing Charts on Proposal to Study NASA Planning for Orbital Activities ..... Naugle
12:00 noon	Lunch

9/24/81

NASA ADVISORY COUNCIL

DETAILED AGENDA/MEETING PLAN

AFTERNOON SESSION - SEPTEMBER 30, 1981

Time	Agenda Item
1:00 p.m.	Report of NASA Advisory Council on NASA Planning
(1:00 p.m.)	- Overview Report of Council ..... Nierenberg
(1:25 p.m.)	- Aeronautics Advisory Committee Report ..... Loewy
(1:50 p.m.)	- Space Science Advisory Committee Report ..... Soderblom
(2:15 p.m.)	- Other Committee Reports ..... Nierenberg
(2:30 p.m.)	- Discussion ..... Nierenberg
2:45 p.m.	Proposal by NASA Advisory Council to Conduct Studies
	- Introduction ..... Nierenberg
	- Study of Long-Range Space Goals ..... Naugle
	- Study of NASA Planning for Long-Duration Orbital Activities .... Naugle
	- Discussion ..... Nierenberg
3:30 p.m.	Adjourn

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October 9, 1981

Mr. James M. Beggs
Administrator
National Aeronautics and
Space Administration
Washington, DC 20546

Dear Mr. Beggs:

The enclosed report represents the recommendations of the NASA Advisory Council and its committees on NASA's long-range planning for Fiscal Year 1983. These recommendations, reported to you in summary form on September 30, were developed in the Council's meeting of August 3-4 and based in part on the extensive work of the committees during the preceding months.

Although the recommendations were developed with respect to the baseline NASA program of the Fiscal Year 1982 amended budget (March 1981), we believe they retain their relevance to the program that will ultimately result from the further reductions presently being imposed. We recognize the difficulties you and the agency face in this situation and offer our support to you in your efforts to maintain a viable institution conducting programs of national importance.

Sincerely,

Bill N.

William A. Nierenberg
Chairman
NASA Advisory Council

Enclosure

cc:
Members, NASA Advisory Council
Dr. Mark

10/1/81

REPORT TO THE NASA ADMINISTRATOR

ON FISCAL YEAR 1983 LONG-RANGE PLANNING

Submitted by the NASA Advisory Council

The NASA Advisory Council (NAC) met on August 3 and 4, 1981, to review NASA's Fiscal Year 1983 planning and to discuss long-range strategies and program concepts that should be reconsidered before the FY 1983 budget proposal becomes firm. The NASA briefings, the NASA committee reports, and the general discussion at the meeting all recognized the future impact of -- and the possible increase of -- major funding needed to complete Shuttle development and procurement and to achieve full operational status. As a result, the Council states at the outset of this report its full support to the commitment to bring the Shuttle to operational service as soon as possible and to provide adequate capability to meet payload, orbit, flight rate, and cost objectives.

- The Council recognizes the short-term funding implications of this necessary Shuttle commitment which is primarily responsible for Fiscal Year 1982 budget limitations on other NASA programs and the likelihood of an equally difficult budget in FY 1983. It is also apparent that the achievement of true operational status is likely to cause budgetary concerns for a year or two beyond 1983.

- The promise of full operational capability of the Shuttle for orbital science, applications, technology, private sector operations, international cooperative programs, and national security operations is too great to permit any different priority of commitments.

In addition to the Council's support of the earliest feasible operational capability of the Shuttle, or perhaps despite it, the Council calls attention to the now critical need to support a vigorous NASA aeronautics and space program. This is necessary to fulfill, in a balanced way, the provisions of the Space Act and National policy. In our view, the exigencies of Shuttle development in a constrained budget environment have already forced excessive reduction in other space activities and in aeronautics, and these efforts are now well below the level needed for "...preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof...". These NASA responsibilities should be funded on an individually rational basis and any further increase in Shuttle funding should be satisfied by corresponding total NASA budget increases, not through reduction of NASA aeronautics and space activity. It is the Council's

conviction, consistent with the economic recovery plan of the Administration, that it is essential to provide real budgetary increases to restore these programs to the level necessary for successful achievement of their respective goals.

Given the foregoing, the Council has identified the following criteria for evaluating the many proposals for expanded and new activities:

- Programs already underway should be granted higher priority than proposed new initiatives (even those of equal value) to insure that present investment and momentum are not lost.

- Evaluation of proposed new initiatives should include these factors:

  - their contribution to the achievement of the National aeronautics and space policy goals and objectives which represent a consensus of the specialized communities that NASA now serves

  - their contribution to continued advancement of knowledge which is NASA's prime purpose

  - for space initiatives, effective use of the Space Transportation System

  - maintenance of program continuity and of a stable, technically creative institutional base supported by adequate facilities

  - advance of future options

More specific recommendations on the fundamental aeronautics and space policy and program issues are contained in the following sections; detailed programmatic recommendations for Aeronautics, Space Science, and Space Technology and Energy programs are included in the corresponding NAC committee reports, Enclosures 1 through 3, respectively.

AERONAUTICS

The most pressing issue in aeronautics is that of maintaining U.S. preeminence in military and civil aviation. NASA's role in this endeavor is essential. The NASA Advisory Council is in full agreement with the report and recommendations of the Workshop on the role of NASA in aeronautics sponsored by the Aeronautics and Space Engineering Board, wherein it was agreed that NASA should be fully engaged in maintaining national facilities and expertise, conducting research, carrying out generic and vehicle class technology evolution, and, when circumstances warrant, conducting technology demonstration and technology validation.

The Council deems that role essential because of the independence of NASA's long-term research and the universal availability of the resulting data. Research and development by industry and the military is generally shorter term, product oriented, and usually neither universally applicable nor available. The unique manpower and facility resources in NASA would be impossible to duplicate in each element of industry and the proven NASA technology transfer mechanisms would dry up if industry and the defense department were forced to assume the total R&D role.

The NASA Aeronautics Research and Technology program is an important part of this Nation's commitment to excellence in aviation. Currently, the United States' position in this field and its resulting strong balance of payments status is being seriously contested by nationalized aircraft industries, or international consortia of such industries, aggressively seeking and gaining major shares of the world market much as they have in steel, ship building, automobiles, communications, and electronics. Less friendly nations, such as the U.S.S.R., are continuing to expend large resources for the development of modern weapons systems including, of course, military aircraft of all types. In spite of the obvious need to bolster United States aeronautical research and technology (R&T) efforts at this time, the total NASA program for this activity has declined by almost 25 percent in purchasing power over the past two years. The NASA Advisory Council recommends that the Aeronautics R&T program be given greater independence from the budgetary pressures imposed upon the elements of the space program, and that its budget level be restored over a period of several years to its earlier purchasing power.

Of particular concern is the apparent policy of the new Administration limiting the NASA role in demonstration and validation of aeronautical technology. Demonstration and validation of technology through systems tests are frequently necessary to define total system impacts and to discover and capitalize on or overcome unanticipated interactions. It is also necessary to demonstrate advanced concepts for civil aircraft under realistic conditions to assure acceptance by the public and certification authorities. NASA must be permitted to undertake such activities when they are clearly in the national interest and when the private sector is unable or unlikely to undertake them alone due to the long-range nature of the investment and the high risk of non-acceptance. We agree that new ways to involve the benefiting private sector to the maximum extent possible should be sought, but not to the exclusion of the historically impressive major NASA contribution to innovation and involvement.

SPACE

The Council believes that the Nation has suffered substantially from the lack of a stable space policy and is gratified that the

new Administration has begun an interagency space policy review. The Council is convinced that identification of new space program goals, to add to presently established goals, is overdue and that a space policy under this Administration should provide for:

- Identification and eventual selection of longer-range goals for the U.S. in space which will provide the framework for a stable ongoing program. The NAC-sponsored Innovation Study and New Directions Symposium in the summers of 1979 and 1980, respectively, looked at future innovative opportunities and activities. They identified two broad candidate goals to be considered by the NASA Advisory Council:

  - to achieve the capability to enable future generations to establish self-sustaining human habitations in space when and if they should decide to do so

  - to understand the present human habitat as a total biogeochemical system, and develop the space systems required to predict its behavior, protect it from natural or man-made catastrophes, and use extraterrestrial resources to help meet its needs

- Utilization of the capability of space systems to monitor indications of the health of "Space Ship Earth." Integrated systems which can measure the current environmental state and keep track of man's impact on his own global environment should be established as soon as feasible.

- Expansion of orbital activities leading from Shuttle/Spacelab through long-duration, Shuttle-serviced space platforms to manned systems (i.e., space stations) for research, construction, maintenance, operations, or other functions. The specifics cannot yet be determined, but we fully believe that this should be the "next step" goal of the civil space program for the decade ahead. NASA's programs in space technology and life science should be focused on making such systems and activities possible. Future science and applications programs will provide the specific definition of requirements or needs that will use the capabilities thus made possible.

The NAC intends to look harder at some of the goals and implied programs noted above and to report on the implications of their selection. We propose to take a practical look at the prospects of such concepts and to attempt an assessment of how man's long-term presence in space can enhance the attainment of specific results.

Space and Life Science: It is essential that the Space Telescope and Galileo receive full national and NASA support with no further delays in their scheduled launches in 1984 and 1985, respectively. Development of the Shuttle-compatible Centaur stage (or equivalent) for Galileo must be accomplished to that schedule. Beyond these imperatives, NASA should seek ways to

- Restore the U.S. spacecraft for the International Solar Polar Mission.

- Maintain the momentum of the Gamma Ray Observatory and the Venus Orbiting Imaging Radar so that they can hold to their currently projected launch dates with no further delays.

- Reemphasize the effective, short lead-time, and modestly-priced Explorer missions; funding should be increased to a level of $80 to $100 million per year.

Breaks in the continuity of the planetary program are already inevitable. It is clear that a fresh look at alternative programs to achieve the goals and objectives in solar system exploration is needed to minimize these breaks and retain the support of the scientific community so essential to resuming more effective and continuous productive activity for the future. The Council's Solar System Exploration Committee is half way through its study on this subject; an interim report will be available this autumn with a final report due in autumn 1982. The study should be far enough along by next spring to contribute to NASA's FY 1984 planning.

- But considered apart from this, NASA should make every effort to mount a meaningful mission to Halley's Comet to initiate the exploration of the small bodies of the solar system by examining this highly active comet during its 1986 appearance.

The Council urges continuation of an effective program of life sciences to support eventual long-duration manned space missions, which it believes inevitable, and for the vital knowledge to be gained from research in biology, medicine, and bioengineering.

Space and Terrestrial Applications: The principal applications issues appear to be the extent to which the Federal government should be involved in activities for which the eventual beneficiary is the private sector -- and the extent of NASA involvement in Federal activities of a more operational nature. These are similar to the issues faced in aeronautics, except that there are few commercial satellite operators and the civilian services in many of these fields normally come from government agencies (agriculture, weather, etc.). Although the economic

implications of space applications may be as large a factor in overall U.S. economic strength as those of aeronautics, their immediate impact is difficult to assess. It is obvious, however, that they have great potential for growth. An instance of applications importance is satellite communications. Foreign competition in this area is growing rapidly and is beginning to impact the U.S. technical and commercial lead.

In the case of flight demonstration of applications technologies, the budget decisions of FY 1982 appear to rule demonstrations out on budgetary grounds identified with the role of NASA vis-a-vis the private sector. The Council strongly recommends that this policy not be applied blindly and that NASA should undertake demonstration projects when they are clearly in the national interest and when, because of total cost, risk, or the long-term nature of any return, the private sector is unable or unlikely to undertake them alone. As in the Aeronautics program, the private sector involvement should be maximized.

Regarding NASA's role in applications programs which lead to operations that are the responsibility of another Federal agency (e.g., NOAA in meteorology), NASA must maintain its role in research and development and, where justified, flight demonstrations.

The Council recommends specifically:

- Continued support of component development for communications equipment in the 30/20 GigaHertz band and implementation of appropriate flight demonstration.

- Additional emphasis on Earth observation remote sensors and data applications techniques, in cooperation with the Department of Defense, to protect the U.S. leadership in this area and ensure a viable later commercialization.

Space Technology: The Council is gratified that the Space Technology program received adequate fiscal resources to maintain its momentum. Effective and timely space technology accomplishments will provide many benefits in increased capability and lower cost for future NASA missions. Once again the question of system demonstration flight projects has been raised, although not in the context of the NASA role vs. those of others. In this program area, mostly within NASA's purview, the question is one of the necessity of such flight projects. The Council believes that flight demonstration projects can be an important aid to the technology transfer process within NASA and endorses their initiation within the NASA space technology organization in appropriate instances.

ENCLOSURES

Enclosures to the Report to the NASA Administrator on Fiscal Year 1983 Long-Range Planning Submitted by the NASA Advisory Council

Reports of the:	Page
1. Aeronautics Advisory Committee	1
2. Space Science Advisory Committee	15
3. Space Systems and Technology Advisory Committee	31

Enclosure 1

Institute Professor

Rensselaer Polytechnic Institute Troy, New York 12181

August 6, 1981

Dr. Jack L. Kerrebrock
Associate Administrator for
Aeronautics and Space Technology
N A S A Headquarters
Code R
Washington, D. C. 20546

Dear Jack,

I am happy to submit the report of the Aeronautics Advisory Committee following its spring and summer '81 review of the NASA Five-Year Plan. The following conclusions and recommendations were generated in separate meetings of the various disciplinary subcommittees of the Aeronautics Advisory Committee and consolidated in a meeting of its Executive Committee on June 18 and 19, 1981. The agenda for the meeting is shown in Attachment 1; those attending in Attachment 2. Every member attending the meeting has had an opportunity to comment on the written version and their subsequent suggestions are reflected in this report. The schedule of the review activity is shown in Attachment 3.

The order of the material in the paragraphs below is not intended in any way to convey a priority ranking. Rather the material is presented, hopefully, so as to start with the most general, becoming increasingly specific as regards program substance. Our reaction to the Five-Year Plan is presented first, followed by discussion of Technology Demonstration and Validation activities (TD/TV). The latter has been done as a separate category since the report of the ASEB summer 1980 study recommended that TD/TV projects should be done only when reasons for doing them meet certain criteria. Also the Committee sees such programs as particularly vulnerable in view of recent budget guidelines. NASA's review of the productivity of major facilities was also presented to the AAC as a separate subject; it is addressed that way in the last paragraphs of this letter report.

GENERAL

The Committee endorses NASA's

- continued drive toward energy efficiency,
- emphasis on perserving expertise and uniquely capable facilities,
- emphasis on building the research and technology base in aeronautics for the nation, and

- continued support of DOD through aeronautical capabilities which are often unique to NASA.

The Committee also endorses, in general terms, the results of the ASEB Summer 1980 workshop at Woods Hole, whose reports have recently been issued.

DISCIPLINARY SUBJECTS

The Committee recommends:

1. Continued support of Computational Fluid Mechanics (CFM) developments, including

- the acquisition and use of such advanced computers as become available and appropriate,
- development of the National Aerodynamics Simulator, and
- continuous and deliberate efforts to keep theoretical developments and experimental developments well balanced, so that neither outdistances nor falls behind the other.

2. The advancement of wind tunnel testing techniques, including the so called "smart wall" developments.

3. Continuing the development of flight research techniques and methodology.

4. Pursuing the objectives of PID-IPAD-CAD/CAM developments at full speed, since IPAD is seen as successful, but only a first step to achieving the capabilities ultimately desired, and PID is viewed as required for the kinds of CAD/CAM advances that are both possible and needed in the aeronautics community.

5. Pursuing at a high level of intensity the FY 83 enhancement to build the R&T Base in the area of flight critical controls.

The AAC is generally concerned that:

6. Under budgetary pressures, NASA is deviating substantially from the Controls and Guidance program of 1979. These disciplinary developments are urgently needed.

7. In deemphasizing "Systems Programs" some worthy R&T Base research on engines, which was embedded in "Systems Programs", is being lost.

SPECIFIC VEHICLE CLASSES

The Committee recommends for:

Transport Aircraft

1. A transport technology integration program emphasizing
   - o advanced materials and structural concepts,
   - o the application of super-critical airfoils,
   - o reducing turbulent skin friction,
   - o active controls, and
   - o advanced propulsion and its airframe integration.

to establish the kind of performance advances, including increased fuel efficiency, achievable through designing transport configurations from the outset to take advantage of these advanced technologies in combination.

Rotorcraft

1. Continuing the 1978 research plan emphasizing
   - o rotor noise, as exemplified by the 1983 QERT initiative,
   - o speed and altitude performance increases,
   - o propulsion R & T Base research,
   - o advancement of all-weather capabilities, and
   - o human factors research.

2. Taking such steps as may be required to eliminate to the extent possible delays in rotorcraft research likely to result otherwise from the consolidation of Ames with Dryden. It is noted that the Langley-Ames transfer of rotorcraft responsibility was a source of delay for rotorcraft research only a short time ago. As worthwhile as these transfers of responsibility and consolidation of flight test activities may prove to be, the Committee believes that the rotorcraft industry in the United States, particularly at this time, can ill afford another delay in rotorcraft research productivity from the NASA centers.

General Aviation (including small commuter transports)

1. Recognizing that advanced technology can improve G. A. aircraft but that existing technology is not being fully used by the G. A. community, deliberating on how to make the latest technology available to the General Aviation industry in the United States, including:
   - o design and fabrication concepts for applying advanced composite materials to G. A. aircraft structures,
   - o development of advanced propellers,
   - o proper integration of propulsion and airframe systems, and
   - o establishing human factors information.

All are seen as needed in the United States General Aviation industry, and not

the least of this effort is to compile and fill our the technological data bases needed.

2. Redirecting stall-spin research to developing design methodologies for improved stall-spin characteristics.

3. Reducing agricultural applications programs as NASA plans to do.

VSTOL Aircraft

1. Bringing current VSTOL concepts to a useful state.
2. Accelerating R & T Base activities in the area of advanced STOL concepts.

Hypersonics

Continuing NASA's current program at present levels, basically as insurance against technological surprise in the military arena.

PROGRAMS IN SPECIFIC AREAS

The Committee recommends the following specific programs in the strongest possible terms:

Large Composite Primary Aircraft Structures (LCPAS)

Particularly in the area of design and manufacturing concepts. The Committee recommends that three contractors be preserved in the design and conceptual stages, where the required funding is moderate, to insure that innovation is encouraged. Where verification of the technology's validity is required for a major component a common element should be developed, in view of the harsh realities of limited funding.

The R & T Base activity accompanying and providing the foundations for the LCPAS program should deal with such important matters as joining technology, thick laminate failure mechanisms, etc.

Second Generation Resin Matrix Composites

Continuing R & T Base efforts of this kind, emphasizing means to achieve damage tolerant, damage resistant, higher strain allowable composites which are readily processable so as to minimize production manufacturing costs.

Advanced Turbo-Prop/Prop-Fan

1. An enhanced turbo-prop/prop-fan program, for transport aircraft, emphasizing

   - materials & structures analysis and optimization technology, propeller-airframe interaction, development of a 15,000 HP gear box, and cabin noise and vibration.

98-418 O—82——101

- accelerating the large scale flight test phase by 1 year

2. Human Factors research aimed at increased operational safety.

Low Drag Research

Redirecting efforts of this kind from simply "laminar flow control" into a broader area with this heading. The emphasis should be on reducing turbulent skin friction drag (of which laminar flow control schemes, passive and active, are just one class of a number of possible aerodynamic interfacing-surface treatments). Regardless of what is added to a broader program, however, the AAC believes that laminar flow control should be pursued through technology demonstration, possibly with NASA in partnership with the DOD in developing and testing a full scale flight vehicle.

Turbine Engine Materials and Structures

- research into the forced response of aerodynamic aircraft turbine engines (FRATE). This is seen as a particularly worthwhile effort, dealing as it does with aerodynamic and thermodynamic excitation and verifying the prediction of forced response.

- research into the conservation of strategic aerospace materials (COSAM), with the objectives of understanding the role of critical materials as they are applied to aircraft turbine engines and of finding hot-section part replacement using either no strategic materials or much lower levels of strategic materials useage.

Small Engine Technology

Pursuing component technology for small turbine engines to reduce manufacturing and maintenance costs both for helicopter and G. A. industries, and to achieve greater fuel efficiencies. Furthermore, the Committee recommends that small engine research include intermittent combustion engines and - in this area - be focused on achieving multi-fuel capabilities.

Variable Cycle Engine

Continuing R & T Base activities for high Mach number configurations (eg fighters, bombers, missiles, etc).

Safety Aspects

1. Continuing fire safety R & T Base programs on materials and fuels, concentrating on smoke toxicity and means to prolong the survival of people involved in aircraft fires, and limiting anti-misting research to feasibility studies.

2. Continuing crashdynamics efforts to develop prediction methodologies

which include non-linear effects and building the kind of data base which will allow confirming analyses by comparison with experiment. (French helicopter crashdynamics experiments, for example, might be quite useful.)

3. Developing advanced seat restraint systems.

4. Continuing research into severe storm effects including wind shear and turbulence, and the effects of lightning on composites and digital electronics. In this regard, NASA might well explore the multi-agency possibilities of a program attempting to minimize the adverse effects of electromagnetic pulse (EMP). Icing research should also be pursued emphasizing the fundamental aspects of formation and adhesion phenomenon and establishing a certification data base which will support systems development for transport, General Aviation and rotary wing aircraft.

Alternative Turbine Engine Fuels

Research emphasizing both the fuel capabilities and limitations of current engines and longer term aspects, including attempts to develop advanced concepts which would sidestep the problems encountered in making engines capable of using broad specification fuels. The latter should have as their objective a flight demonstration by fiscal year '86.

TECHNOLOGY DEMONSTRATION/VALIDATION REVIEW

The Committee studied NASA's current programs and future plans for technology demonstration, technology validation (TD/TV) activities. This review began with the Committee endorsing the criteria by which NASA could judge in each instance whether a technology demonstration or technology validation program was justified, as these criteria are listed in the ASEB Woods Hole 1980 Summer Study report (Attachment 4). Subsequently, the Committee agreed that

- the LCPAS program,
- the LFC Program (which we prefer to see called a "Low Drag" program),
- active controls technology and
- energy efficient engine (E^3) technology

all involve a great deal more than just TD/TV, and that all of these programs should culminate in TD or TV phases.

The Committee believes that the rotorcraft integrated control/program for all-weather operations satisfied the ASEB criteria, too, and we endorse it.

The AAC views the Accelerated Transport Operating Program System (ATOPS) as a necessary program, but feels it is misclassified as TD/TV. We regard this as vehicle class technology evolution. Similarly, the HIMAT follow-on is seen as a program which should be restricted to determining the stability derivatives of Canard configurations, in which case it is not TD/TV, but R & T Base research.

As regards large Rotorcraft, the Committee believes that this constitutes a worthwhile effort, but that NASA should "let DOD do it" in which case, NASA should then attempt to have its own technology program for large rotorcraft "piggy-back" on the DOD program. The AAC recommends that NASA do the same in any large tilt-rotor effort. In this case however, we wholeheartedly endorse full utilization of the XV-15 as a valuable asset from which all possible research information should be gained.

Finally and in general, the AAC believes that flight tests of systems carried out in the TD/TV mode are necessary if we are to realize the synergistic gains and discover and overcome unanticipated interaction problems. Both are often only revealed in full scale flight tests of complete systems under realistic conditions. In reemphasizing the R & T Base, the Committee urges NASA not to drop all applications. In fact, the AAC notes that to get at the basics in many instances requires full investigation of applications.

REVIEW OF FACILITIES PRODUCTIVITY

The AAC applauds NASA's internal review of facilities productivity, agreeing in general that NASA should consider means by which the output from these costly and extremely valuable facilities can be increased. While endorsing man-power and energy economy, we believe that man-power and energy savings programs are misdirected when applied to such facilities. It seems obvious that the value of research output increments available through increased use of these facilities far outweighs the increased costs. In line with this thinking, the AAC recommends that the unique facilities at NASA merit a yearly investment of some small percentage of their capital value as measured by replacement costs. This investment should be used each year to maintain and/or upgrade these facilities to preserve their abilities to contribute to the aeronautics research program.

The Committee notes with approval NASA's plans to continue the current review of facilities productivity so as to include considerations of:

- skill mix among personnel
- quality of research output (as well as quantity) and
- system efficiencies as they trade off among investments for more capable models, instrumentation, data analysis and data processing techniques, as well as investments in the test facilities themselves.

A last rather general comment regarding interactions. The Committee recommends that

- NASA should increase interactions with industry in the area of aeronautics so as to be fully and completely aware of industry's IR&D programs.
- DOD interfaces such as those with the AFWAL program should be increased.

- NASA should be current and continuously aware of simulator useage by other organizations, eg U.S. airlines.

- NASA should have constant contact with aircraft design, fabrication, and test practices both in the United States and abroad.

In making these last recommendations, the Committee is aware of interagency committees on which NASA sits, NASA's present involvement in IR&D reviews, and other worthwhile interaction opportunities. We also are aware of NASA's problems with travel funds. Nevertheless and all these considerations notwithstanding, the Committee's recommendations are made most strongly as regards the Administrator and Associate Administrator positions, other critical positions in headquarters and within the research centers.

I hope these somewhat lengthy comments and recommendations will prove to be timely and useful. It is a pleasure to have been involved in this activity so important to the economic health and the defensive capabilities of our nation.

Sincerely,

Bob

Robert G. Loewy

cc: Dr. W. Olstad

Attachment #1 (page 1)

NAC AERONAUTICS ADVISORY COMMITTEE

EXECUTIVE SUBCOMMITTEE

June 18-19, 1981

NASA Headquarters (Room 625)

AGENDA

June 18, 1981

8:30 - 8:45 a.m.	Opening Remarks	Robert Loewy
8:45 - 9:15 a.m.	Current Status of NASA FY 1982 Budget and Long Range Plan	Walter Olstad
	SUBCOMMITTEE CHAIRMEN'S REPORTS	
9:15 - 9:50 a.m.	High Performance Aircraft Systems	William Hamilton
9:50 -10:00 a.m.	Discussion	
10:00 -10:15 a.m.	Break	
10:15 -10:50 a.m.	Aerodynamics	Joseph Cornish
10:50 -11:00 a.m.	Discussion	
11:00 -11:35 a.m.	Materials and Structures	Martin Goland
11:35 -11:45 a.m.	Discussion	
11:45 -12:45 p.m.	LUNCH	
12:45 - 1:20 p.m.	Rotorcraft Technology	Troy Gaffey
1:20 - 1:30 p.m.	Discussion	
1:30 - 2:05 p.m.	General Aviation Technology	John Olcott
2:05 - 2:15 p.m.	Discussion	
2:15 - 2:30 p.m.	Break	
2:30 - 3:05 p.m.	Safety, Human Factors and Operating Systems	John Smith
3:05 - 3:15 p.m.	Discussion	

June 18, 1981 -- continued

3:15 - 3:50 p.m.	Aircraft Controls and Guidance	Duane McRuer
3:50 - 4:00 p.m.	Discussion	
4:00 - 4:35 p.m.	Transport Aircraft Technology	Russell Hopps
4:35 - 4:45 p.m.	Discussion	
4:45 - 5:20 p.m.	Aeronautical Propulsion Technology	Maurice Shank
5:20 - 5:30 p.m.	Discussion	
5:30 p.m.	ADJOURN	
6:30 p.m.	DINNER	

June 19, 1981

8:30 -10:15 a.m.	Discussion of "Strawman" Consolidation of Subcommittee Reports
10:15 -10:30 a.m.	Break
10:30 -11:30 a.m.	Continuation of "Strawman" Consolidation of Subcommittee Reports
11:30 -12:30 p.m.	LUNCH
12:30 - 2:30 p.m.	Discussion of Subcommittees' Review of NASA Technology Demonstration and Validation Programs.
2:30 - 2:45 p.m.	Break
2:45 - 3:45 p.m.	Discussion of OAST's Facility Productivity Improvement Program
3:45 - 4:30 p.m.	Summary of Meeting Results to OAST Management
4:30 p.m.	ADJOURN

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Attachment #2

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A. FIVE YEAR PLAN AAC REVIEW

1. SUBCOMMITTEE MTG SCHEDULE: SPRING '81

A. Aerodynamics	May 5, 6	(HDQ's)
B. Materials & Structures	June 2, 3	(HDQ's)
C. Propulsion	April 29, May 1	(HDQ's)
D. Controls & Guidance	May 19-21	(LaRC)
E. General Aviation	May 14, 15	(LaRC)
F. Rotorcraft	April 21, 22	(HDQ's)
G. Safety, H.F.'s & Op'g Syst's.	June 3-5	(HDQ's)
H. Transport A/C	May 20, 21	(HDQ's)
I. High Performance A/C	May 26-28	(HDQ's)

2. EXECUTIVE COMMITTEE MTG — June 18, 19 (HDQ's)

3. SUMMARY LETTER:

A. Circulated for Comments	July 17-27
B. Submitted to Dr. J. Kerrebrock	Aug 6, '81

Attachment #3

TD/TV Criteria

NASA's Role in Aeronautics ASEB Report 1981

The Workshop Unanimously Recommended that NASA Undertake Technology Demonstration and Technology Validation when the Potential Benefits to the Country are Judged to be High After a Careful Case by Case Review.

These Circumstances will, in General, be Defined by Combinations of the Following Factors:

- o Industrial Knowledge of Potential Market
- o Technological Risk
- o Profit Potential
- o Capital Requirements
- o Industry Capability
- o Gestation Period
- o Threat of Foreign Competition
- o Potential Impact on National Welfare; and
- o Possible Government Regulation.

Enclosure 2

UNITED STATES
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August 3, 1981

Memorandum

To: Members of the NASA Advisory Council

From: Chairman, NASA Space Science Advisory Committee

Subject: Attached SSAC Recommendations

The Space Science Advisory Committee met at NASA Headquarters from June 29 through July 1, 1981. The Committee recognized that the grave situation that has been facing Space Science over the last few years is now becoming critical. The combined factors of the budget reductions in FY 80 and 81, slips in the Shuttle development, and lack of a high energy launch capability for deep space misions, had by last year at this time caused major slips, reductions and cancellations in all areas of Space Science. The situation during the last year has continued to deteriorate. For the first time an approved mission, well into the implementation phase was cancelled. That mission, the International Solar Polar Mission, was a two spacecraft cooperative mission between ESA and NASA. Loss of the U.S. spacecraft has jeapordized not only the high scientific yield of the Mission but also the credibility of U.S. cooperative ventures with other nations. Galileo, a Jupiter orbiter and probe mission, still faces uncertainties in NASA's ability to meet launch requirements. Loss of the Galileo Mission would almost certainly signal the end of the epoch of U.S. planetary exploration. Realizing the gravity of the situation the Committee formulated the attached recommendations. Unlike most committee recommendations, we have tried to identify the critical issues and to prioitize the action that needs to be taken. The recommendations are presented for your review and possible concurrence by the NAC.

Appendix XI

SSAC Recommendations on FY 1983 Critical Issues

As a result of the budget amendments of the past two years as well as continued questions concerning the availability of high energy upper stages for deep-space planetary missions, the Space Science program approaches the formulation of its FY 1983 budget facing a number of major uncertainties. In these recommedations we address what we believe to be the most critical issues which must be dealt with in the short term. Recommendations on other issues are discussed elsewhere.

The SSAC reaffirms that the Galileo mission to Jupiter, the earth-orbiting Space Telescope, and the International Solar Polar Mission are critical items of the highest priority within the Space Science program. These broadly conceived missions will be of immense value in the exploration of our universe and should be pursued to completion without further delay.

Galileo has already experienced serious slips caused by delays in the Shuttle and Shuttle upper stage readiness. It is now clear that the best understood technical solution to the Galileo launch vehicle problem and the only one which can keep it on track for a 1985 launch is the Shuttle-Centaur. The SSAC urges NASA to proceed to develop the Shuttle-Centaur on a schedule which will ensure the successful launch of Galileo in 1985, and support the launch of the International Solar Polar Mission in the 1985/1986 time frame. In addition, this launch capability will have far-reaching consequences for the future of the National Solar System Exploration program. A broad program of solar system exploration from now until the end of the century will require a vehicle with this performance capability.

The SSAC expresses its profound dismay over the drastic reduction in the U.S. participation in the International Solar Polar Mission. The reduction has resulted in the cancellation of the U.S. spacecraft in this joint, two-spacecraft mission with the European Space Agency. It is our recommendation that restoration of a two-spacecraft Solar Polar Mission be treated as an item of highest priority which must be addressed in the formulation of the FY 1983 budget. The SSAC reaffirms that a two-spacecraft reconnaissance of the three-dimensional properties of the Sun and heliosphere is a scientific mission of the greatest importance. We urge NASA to make every effort to preserve as much of the U.S. participation in ISPM and the two-spacecraft concept as is feasible.

The 1985/1986 apparition of Halley's Comet presents a unique scientific opportunity to initiate the exploration of the small bodies of the solar system and to examine a highly active comet. It has become clear that the U.S. Halley Intercept Mission would be singularly able to carry out crucial studies of Halley's Comet and, in its current concept, would be far and away the most capable of the various missions to Halley that are now being considered or developed. We believe that this mission is an important one and should be done if an opportunity presents itself.

We note that both the International Solar Polar Mission and the Halley Intercept Mission can be launched with existing vehicles or vehicles now in development other than the Shuttle-Centaur. Should the development of Shuttle-Centaur be delayed for any reason, we urge that ISPM should continue to proceed toward launch on an alternative launch vehicle in the currently planned time frame. Under these circumstances, the option of proceeding with the development of the Halley Intercept Mission should be carefully considered by NASA. In such a situation, development of Galileo should proceed towards launch at the earliest opportunity. The Galileo mission represents science of the highest priority. It must remain a key element of the Space Science program.

Finally, we wish to point out that all of the missions now under way have emerged from a comprehensive planning process and have undergone a searching examination of their merit by the broad scientific community prior to their being started. The lengthy planning and development cycle and the long-term commitments on the part of University/Industry/Government teams required to execute such missions demand that missions, once started, be completed.

SSAC Statement on the International Solar Polar Mission (ISPM)

The SSAC is most deeply concerned over the severe truncation of the U.S. participation in the ISPM. This has resulted in the cancellation of the U.S. spacecraft. ISPM is an integral part of the nation's effort to study the global properties of the Sun and its surrounding region and the Sun's influence on the Earth.

Established and orderly procedures were followed in planning ISPM and in obtaining Congressional approval. The mission is now three years into the implementation phase. Cancellation of a mission that is this far advanced is unprecedented. In this case it is also an abridgement of the U.S.'s committment to ESA and its member states. ESA agreed to participate in ISPM with the understanding that it was to be a two-spacecraft, coordinated mission. Seventeen European institutions are involved in six of the eight instruments on the U.S. spacecraft. Cancellation of the U.S. spacecraft will have serious ramifications for the future of collaborative scientific efforts with the Europeans. This action, in fact, calls into question the value of the United States committment in other areas of international cooperation.

This mission is of such importance that NASA and ESA have developed several reduced-cost alternatives for re-establishing a two-spacecraft mission. The SSAC strongly recommends the reinstatement of the U.S. ISPM spacecraft. The SSAC reaffirms that a two-spacecraft mission that can determine the three-dimensional and dynamic properties of the Sun and the heliosphere remains one of the highest priorities in space science for NASA.

SSAC Statement on Halley Intercept Mission (HIM)

For the last several years, the Space Science Advisory Committee has strongly endorsed a new start of a comet mission in the immediate future, stating: "Such a mission is fully consonant with the highly desirable goal of systematically investigating representatives of different classes of objects in the solar system. In this way the necessary data will be gathered for addressing such fundamental questions as the origin and evolution of the solar system. Comets are of particular interest since they represent pristine samples of material that formed in the outer solar system."

The Halley Intercept Mission represents a response to a unique and important opportunity to explore a very active comet. Halley's comet is the only comet of this type whose orbit is well enough known to permit a close flyby with a spacecraft. Furthermore, since Halley's orbital period is about 76 years, almost a century will pass until we have another opportunity to study it close up if we do not take advantage of its passage through the inner solar system in 1985-1986.

Plans have been laid by several foreign countries, including Japan, the USSR, and Western Europe, to send spacecraft of various types to Halley during the 1985-1986 opportunity. However, there are several ways in which the proposed Halley Intercept Mission represents a significant advance over these missions. First, its far superior and proven imaging system will permit both observations of the cometary tail during an extended observatory period and good views of its nucleus during closest approach. The former is extremely valuable in light of well-documented dynamic phenomena exhibited by cometary tails and the latter is essential for understanding the nature and structure of the place where almost all the comet's mass resides. Second, optical navigation will permit passage quite close to the comet's nucleus, thereby insuring sampling of the parent molecules of the molecular fragments found at greater distances in the coma. This will provide unambiguous data about the chemical makeup of the nucleus. For the above reasons, the SSAC is highly impressed with the scientific value of the currently proposed Halley Intercept Mission and strongly endorses it. This mission will yield the highest science return by far of any of the non-U.S. Halley missions mentioned earlier.

Crucial additional information on the chemical composition of Halley's comet and other comets can be obtained by collecting dust and gas samples and returning them to Earth for sophisticated elemental and isotopic analysis. Initial studies indicate that such sampling may be both practical and comparatively inexpensive as an add-on for a fly-by mission, such as HIM. We urge that further studies of this extremely important possibility be conducted to further define its logistics and costs.

**SSAC Recommendations on the
Explorer Program
(Program Justification)**

The Explorer Program has always been one of the key elements in the OSS basic program strategy. Fifty-five (55) NASA domestic and 26 international cooperative Explorers have been launched. Some of the significant accomplishments are listed in the attached table. The importance of this activity will continue and may be even more profound in this decade, particularly if the developing trend toward a lower frequency of major program new starts continues. Among the key factors that make the program so valuable are:

1) the high scientific productivity as shown by new discoveries listed in the attached table, comments below regarding publications of scientific results, and the success of Explorers in laying the foundation for subsequent observatory class missions;

2) the potential for relatively rapid response to new areas of science;

3) the level-of-effort nature of the program which is intended to permit regular start of modest scale programs as well as to deal in a flexible way with development problems that may naturally arise in an ongoing program;

4) the opportunity that it provides to develop innovative technologies;

5) the opportunity that it provides for development of program management and hardware construction skills among university personnel;

6) the maintenance of in-house program management and technology skills at NASA Centers; and

7) the training of industry personnel in new techniques.

The scientific impact of Explorers can be measured in a number of ways. The attached table lists some discoveries and developments which have opened the door for further exploration and systematic studies. Explorers also produce abundant scientific results. For example, Explorers in the discipline of astrophysics typically lead to as many observational papers per year as the major ground-based reflectors. In 1980, 13% of the Ap. J. observational papers were based on Explorer data and the impact is even greater in atmospheric and space plasma physics. Furthermore, Explorers often provide the proving ground for subsequent programs which have greater impact.

Explorers provide a possibility of responding to possible new developments on fast-breaking areas of research in less than five years, whereas major new starts may require up to 15 years from conception to launch.

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In the Explorer level-of-effort management approach is that it provides the flexibility to cope with budgetary problems which arise in developing state-of-the-art technology.

Since Explorer missions frequently involve flying the most up-to-date instruments, they often lead to the development of new technologies which are subsequently available for use on other missions. Examples include items like low-power, large-scale integrated circuits, on-board computers, gas-filled proportional counters, star trackers, momentum wheels, magnetic torquing, low-cost mirror fabrication, instrument control technology, and, in the future, Dewars (IRAS).

A continuing, active Explorer program provides a stable training ground of modest scale for new scientific groups, for managers at Centers and for new scientific groups and engineers in industry. Maintenance of these skills is crucial for the success of major new programs.

Present Situation

A recent report on the Explorer program, by Battelle Columbus Laboratories, stresses several points that must be dealt with in planning the future Explorer Program.

The most crucial issue to be faced in designing a program for Explorers in the next 15 years is the drop in real dollars available to the program. Although inflation allowances have been granted in recent years, during the years 1976 through 1979 the actual funds available for Explorer expenditures were 30% lower than the inflation-corrected 1965 budget. At the same time, a need for more complex Explorers has emerged as a consequence of the steady maturation in all fields of space science research. This situation accounts for some of the current backlog in new starts in the Explorer Program. In this regard, foreign collaboration has been important in preventing the recent, more expensive spacecraft from having an even deeper effect on the overall program balance and launch rate.

The next most important issue is the question of the financial scope of programs that have been handled as Explorers. Although the basic program content has not changed, the trend toward larger Explorers (IUE, ISEE, IRAS) in the face of a fixed budget is causing a substantial drop off in the frequency of Explorer starts and launches. As a result, important missions in many areas of space science are being delayed.

Finally, use of in-house manpower for Explorers has traditionally been an important factor in the program. A recent decision to do several Explorers out-of-house has altered this aspect of the program in recent years, so that by 1979 the in-house manpower amounted to less than 15% of the total Explorer Program, as compared to 35% troughout the 70's.

Recommendations for the Future

In light of the above facts, we make the following recommendations to OSS:

1) NASA should seek to augment the total Explorer funding to a level of $80-100 million/year;

2) start of and/or launch of one or two Explorers/year should be a planning goal;

3) NASA should continue to encourage inexpensive Explorer missions, since a mix of large and small missions is desirable;

4) NASA should study possible implementation of standard Explorer hardware that could ultimately reduce costs of major Explorer missions;

5) when it is in NASA's best interest, international collaboration should continue to be sought; and

6) the use of in-house manpower at the level of the early 70's should be a continuing aspect of Explorer Program.

These points are elaborated below:

1) A doubling of total purchasing power is fully justified to meet the new requirements which we anticipate will be placed on the program in the 1980's. The increases can be sought in increases in the development line item, in mission operation and data analysis and in the use of center manpower.

2) For the health of the program, a launch rate of one-to-two Explorers/year is an important goal. Within the total Explorer program budget, NASA should attempt to constrain individual project costs not to exceed the one year's worth of Explorer resources. More expensive items should generally be treated as new starts and proposed as such. The ability to maintain program balance between disciplines depends upon the implementation of this recommendation.

3) NASA should encourage flight of satellites that are inexpensive, yet responsive to new concepts. Several positive aspects of the Explorer Program are related to the existence of a mix of small and large instruments (e.g., the recommended launch rate, programmatic flexibility, and training of university groups). NASA should continue to operate the Explorer Program in a way that encourages low-cost payloads.

4) Some investment in Explorer spacecraft hardware might help lower Explorer costs in some cases. For instance, the existence within the Explorer Program of a standard three-axis pointer capable of carrying a one-meter telescope might decrease costs of several prospective Explorers. Such hardware must be considered as enhancing capabilities and would only be cost-effective if a discipline worked within the new capability thus made available

(just as everyone now lives within weight constraints). NASA's current platform studies are of great interest in this context.

5) International collaborations are particularly important for large Explorers, and should be sought when a scientific goal (widely agreed upon) cannot be met without further scientific, technological, or cost-sharing assistance.

6) Use of in-house manpower provides new technology and management experience to the centers and enhances the capabilities of the program in the face of limited Explorer funds. This symbiotic relationship is important to the centers and to outside scientists.

TABLE I
Some Explorer Contributions to Space Science

Explorer I (S-1)	Discovered Van Allen belts
Explorer 6 (S-2)	First measurements of ring currents
Explorer 17 (S-6)	Discovered belt of neutral Helium atoms
Explorer 18 (IMP-A)	Confirmed solar wind shock on magnetosphere
Explorer 19 (AD-A)	Helium bulge, diurnal variations and gradient pole to equator
Explorer 35 (IMP-E)	Lunar wake studies
Explorer 42 (UHURU) (SAS-A)	X-ray survey of celestial X-ray sources (opened up field of X-ray astronomy)
Explorer 43 (IMP-I)	Solar wind/interplanetary magnetic field relationship (laid out outline of the magnetosphere)
Explorer 45 (SSS)	Detailed measurement of ring current
Explorer 48 (SAS-B)	Sky survey of high energy gamma helped lay the foundation for GRO)
Explorer 53 (SAS-C)	Studies of the final stages of stellar evolution through [illegible] of X-ray pulsars in binaries.
ISEE, AE, IMF I-J	Systematic studies to study solar/ magnetospheric and solar/atmospheric relationships
IUE	Study of intergalactic matter (discovery of hot halo of gas around our galaxy and subsequent discovery of possible halos around two other galaxies) and (first extensive comparative study of stellar chromospheres which could help lead to understanding of the long term evolution of the sun)

SSAC Recommendations on Gravity Probe-B (GP-B)

The purpose of the gyrorelativity experiment, Gravity Probe-B, is to carry out a fundamental new test of general relativity by measuring two effects. The first, called the geodetic precession, is the relativistic precession, is the additional precession produced by the twisting of space due to rotation of the Earth itself. Measurement of the latter effect, which is due to the relativistic dragging of inertial frames, would constitute an entirely new test of the theory. The gyrorelativity experiment is the only currently foreseeable means to verify the existence of a magnetic-like effect of gravitation.

The experiment is an extraordinarily demanding one and has required a lengthy period of difficult technology development. The SSAC affirms the fundamental scientific importance of this program which is a potential landmark experiment in physics. We believe that, should a suitable mode for implementation of this experiment be identified, it should be included as part of the Space Science program. However, we are concerned about certain aspects of the possible program implementation which we believe must be addressed prior to any final decision being reached to proceed with the development of the gyrorelativity experiment.

Our fundamental concern is that the financial scope of the mission is incompletely understood at the current time. This uncertainty must enter into the consideration of the best way to implement the program. One possible approach to implementation now being considered would be to develop the mission as part of the Explorer program. The SSAC endorses this approach in principle. However, it is clear even now that this mission could not and should not be accommodated within the Explorer program given the current level of the Explorer line. The Explorer program would have to be substantially augmented (see separate recommendation on Explorers) in order to even contemplate proceeding with GP-B as an Explorer. There must be a realistic assessment of the cost of this mission.

We recognize that the GP-B mission is now undergoing a Phase B definition study and that the issues we have raised will be much better understood when that study is completed. In particular, the issue of the best way of funding the mission should be much clearer at that time. If the mission can be developed within a suitably augmented Explorer program, the SSAC believes that this would be the best way to proceed. If it cannot be done as an Explorer, the mission should be re-reviewed as a new start candidate along with the other new start candidates by the SSAC as part of the next budget cycle. Finally, no matter how the mission is ultimately implemented, the extreme technical difficulty of the gyrorelativity experiment must be recognized. Any decision to proceed with this mission should be made with great caution. There will be a continued need for careful assessment of the status of the technology of the experiment throughout the remainder of the Phase B studies, as well as throughout the development phase.

SSAC Statement on Origin of Plasmas in Earth's Neighborhood (OPEN)

In accord with previous strong endorsements, the SSAC reaffirms that the OPEN mission represents science of fundamental importance and should be pursued as a new start at the earliest opportunity, preferrably in FY83. The SSAC recommends that a science working group be formed at the earliest possible opportunity to refine the definition of this mission. Should budgetary constraints preclude an FY 1983 start for OPEN, the SSAC recommends that adequate Advanced Technological Development funds be made available to support this science working group activity in preparation for an FY 1984 new start.

The OPEN mission is an essential element in NASA's goal to achieve a quantitative understanding of the near-Earth environment of space. OPEN will provide the first global description of the dynamics of the magnetosphere; it will complete the first assessment of the role of plasmas in the solar-terrestrial energy chain; and it will extend the exploration of our space environment by making the first systematic survey of the extended geomagnetic tail. The OPEN mission charts a new course in studying terrestrial space plasmas by treating the magnetosphere as a global system, responsive to the solar wind input whose response must be simultaneously measured at critical points in that system.

The OPEN mission is an integral part, and will greatly extend the scientific yield, of other efforts that NASA is planning to undertake in the late 1980's. A major part of this effort will be the Shuttle-based active experiments which will probe the physics of the near-Earth plasma under controlled conditions. OPEN will directly support the active experiments program and also build upon this physical understanding by extending our investigations into the more distant equatorial magnetosphere, a region whose environmental conditions and behavior we will have to understand as our space applications satellites become more sophisticated. In the area of solar-terrestrial physics, the Interplanetary Plasma Laboratory (IPL) of the OPEN mission can provide measurements in the ecliptic plane that would augment the global study of solar and heliospheric conditions to be provided by ISPM. In conjunction with the UARS mission of OSTA, OPEN will provide new opportunities to investigate quantitatively the coupling of magnetospheric and solar phenomena with the Earth's atmosphere.

OPEN will study the two principal sources of plasma in geospace (the solar wind and the ionosphere) and the three principal energy storage regions in geospace (the plasmasphere, the ring current, and the geomagnetic tail). In the same sense that the analysis of a laboratory plasma requires a complete and strategically located set of sensing instruments, a quantitative study of the interrelations of the plasmas in the several regions of geospace requires, as a minimum, four fully-instrumented spacecraft. The OPEN mission consists of the Interplanetary Physics Laboratory (IPL), which can measure the solar wind and solar energetic particle inputs to geospace; the Polar Plasma Laboratory (PPL), which can measure the ionospheric output at high latitudes and the energy deposition into the high latitude neutral atmosphere; the Equatorial Magnetosphere Laboratory (EML), which will study the ring current and the plasmasphere; and the Geomagnetic Tail Laboratory (GTL), which will undertake, for the first time, the systematic exploration and study of the dynamics of the geomagnetic tail. The four spacecraft are the minimum

TD/TV Criteria

NASA Advisory Council MTG of Aug. '80

The NASA Advisory Council, at its August 1980 Meeting, Suggested the Following as Criteria for a NASA Public-Interest Role "in Accelerating the Development of Aviation Technology Needed not only for Military Purposes but to Enable Industry to Utilize this Technology to Compete."

A. There is a Significant Potential Benefit to the Nation (Economic, Environmental, Quality of Life, etc.)

B. There is a Significant Spin-Off or Applicability of Resulting Technology to National Defense even though the Activities are Civil Aviation Projects.

C. The Project must be Carried out to validate the Technical and Economic Feasibility of Required Federal Safety and Environmental Regulations.

D. The Cost or Risk is so great as to be a Serious Deterrent to Timely Incorporation by the Private Sector.

E. The Current Preeminence of United States' Industry is threatened by Foreign Competitors who are Advancing Rapidly and Likely to Encroach on the United States' Part of this Particular Market.

required to cover the three storage regions, and the source in the solar wind.

The extensive planning of OPEN, which has occurred over the last few years, has yielded a mission that will make maximum use of the data that will be returned, and that has the flexibility to respond to the discoveries that will surely be made. An interactive data system, which will be the next generation data system beyond those developed for the Atmospheric Explorer and Dynamic Explorer Missions, will facilitate the quantitative modeling efforts that will be an integral part of the project. The active theoretical community in the field, which in recent years has had a healthy interaction with laboratory plasma theorists, will play a major role in this project. Each of the OPEN spacecraft has an adequate on-board propulsion system; orbital adjustments can be made during the course of the mission to optimize data usefulness for direct use in mission efforts of theory and modeling.

OPEN mission objectives include problem areas of great importance to the laboratory plasma physics community. Similarly, the results from OPEN will provide profound advances in our knowledge of planetary and stellar magnetospheres. Thus, the integration of theory and experiment in the OPEN program will promote useful exchanges between the space plasma physics community with both the laboratory and the astrophysical plasma physics communities.

Plasma processes that occur in the geospace environment impact both earth-based and space-based technological systems. These include diverse examples such as radiation damage effects on satellite components, geomagnetic storm effects on power line and telecommunication systems, and magnetic field fluctuation interference with geophysical exploration. The IPL spacecraft can provide an early warning of impending geomagnetic storms, which directly effect the systems described above. Furthermore, global auroral imaging from PPL will provide a direct, continuous measure of the subsequent interaction of geospace disturbances with the upper atmosphere.

There is much present concern with weather and climate, and how these might be affected by the geospace environment. Global information is lacking on energy sources and their transport through geospace to explore these possible effects. The OPEN mission will provide the data and framework to better assess the possible relevance of geospace energy processes to upper and lower atmospheric processes.

In summary, as recommended, the OPEN mission is especially appropriate and worthy for a new start at the earliest opportunity. The scientific questions regarding the detailed interactions between the several components of geospace are sharply defined and will serve to provide quantitative advances in our understanding of magnetospheric physics. The necessary instrumentation is developed to yield the required measurements of particle composition distribution and of electric and magnetic field variations. Computer systems exist for large amounts of interactive data manipulation and handling within the unique data management system provided. Theoretical developments in plasma physics and in computational methods (partly as a result of interaction with the nuclear fusion program) are ready to utilize for exploiting and interpreting data from OPEN. Further, the OPEN project will provide new results applicable to other fields of science and technology.

SSAC Recommendations on Science and Applications Space Platform (SASP)

The SSAC has reviewed the status of the Science and Applications Space Platform (SASP), a concept based on the 12.5 KW power module now being studied by the Marshall Space Flight Center. The first stage of the SASP concept consists of a basic module that provides power thermal control, data handling facilities, and several ports on which experiments can be mounted. The Space Shuttle is used to transport and install the scientific payloads. Current planning calls for a system that has thrusters capable of maintaining an orbit indefinitely, with revisits approximately every 6 months by the Shuttle to service the module, and to exchange and/or refurbish payloads. The involvement of astronauts in experiment adjustment, refurbishment, and replacement appears to be an effective and useful role for man in space.

The present design is proceeding in a way that appears to be very well suited to the long term needs of many segments of the space science community. A number of important, large-scale scientific investigations in several disciplines require orbital stay times longer than the few days available with Spacelab, but less than the multi-year periods characteristic of free flyers. The projected stay times of approximately 6 months for experiments, plus the ability to refurbish and change payloads, will meet many of the requirements expressed on behalf of the Space Science Board by the Committees on Solar and Space Physics (CSSP) and Space Astronomy and Astrophysics (CSAA). SASP is being designed with interface specifications that appear to be much simpler than those used for Spacelab, and these changes, together with the longer period in orbit, will provide a basis for a cost-effective program of highly productive Space Science investigations in low earth orbit. At the same time, the flexibility to perform forefront experiments in a flexible, low-cost manner should be preserved.

NASA now faces a serious problem because individual new start missions have recently tended to grow. Since the budget for Space Science has been essentially constant for several years, small-scale opportunities for substantial science tend to be squeezed out. The Space Platform can increase substantially the frequency of opportunities in a manner analogous to the Explorer program with two further advantages: smaller experiments can be included, thus increasing the number of innovative experiments, and multiple experiments can be conducted in a coordinated manner, using both new and existing instruments in an optimum way. The latter advantage is valuable in several problem areas that require many instruments, both large and small, to explore broad ranges of wavelength or phenomenology. The Solar-Terrestrial Observatory can be cited as an excellent example of meeting the need for coordinated observations with a mixture of both newly-developed and existing Spacelab experiments that could be brought to bear simultaneously upon a set of complicated and interrelated phenomena.

The SSAC supports the concept for SASP as it is now emerging as a valuable tool for carrying out a wide variety of near-Earth experiments. The committee also supports the planned Phase B studies leading toward a potential new start. The SSAC believes that as a part of these studies a comprehensive review of potential interferences between experiments be carried out immediately, and become an ongoing part of the planning. Electromagnetic interference, chemical contamination, vibration, and other mechanical

interferences, are all potentially troublesome unless proper planning occurs in the early stages. A substantial body of experience now exists, and the problems can be dealt with in known ways if they are properly anticipated.

Finally, the SASP project should be complimented on the close collaboration that has existed continuously between the project design group and the scientific community. Future work on the project will profit from continuation of this cooperation, both to insure that accidental lapses in design requirements do not occur, and to keep the project abreast of important new scientific developments.

SSAC Recommendation on the In-orbit Repair of Solar Maximum Mission (SMM)

Repair of the Solar Maximum Mission in orbit by Shuttle astronauts has been proposed to restore the full capabilities of the observatory. The major repair consists of replacement of a failed spacecraft subsystem. Additional minor adjustments of two experiments, and major repair of one inoperable experiment, would complete the refurbishment. A restored capability for SMM observations will allow the study of major flares in the post-maximum phase of the solar cycle; the benefit to the coordinated observatory functioning from the experience of the initial nine months' observations cannot be overemphasized. Certain important solar observations not directly related to flares may also be accomplished before the eventual recovery and retrieval of SMM by the Shuttle, and an increase in the satellite altitude would be desirable to provide further time in orbit.

The SSAC recommends that the necessary repairs be carried out as promptly as is consistent with STS capabilities. The SSAC regards this as a valuable demonstration of our capability for in-orbit repair of complex spacecraft, which may be directly applicable to future missions such as the Space Telescope. The restoration of SMM observational capability has the highest scientific merit.

Enclosure 3

Space Systems and Technology Advisory Committee

SSTAC EXECUTIVE COMMITTEE MEETING
16-17 JUNE 1981

The Executive Committee of the SSTAC met to assess the results of the individual meetings of the six subcommittees who recently reviewed OAST's advanced objectives and planned programs.

In general, each subcommittee was in accord with the currently planned activity. However, there were five issues raised which deserve additional consideration in the coming months. They are:

1. The present Shuttle solid propellant rocket boosters need to be evaluated along with the use of liquid propellant boosters to meet future increased performance requirements, and to address the environmental issues posed by solid propellant fallout as the Shuttle flight schedule increases. Therefore, additional system development and cost studies are needed on the use of LOX-hydrocarbon versus the solid propellant strap-on boosters for Shuttle. Firm milestones for the next few years should be established and performance and environmental assessments made prior to establishment of a high cost level development program.

2. Planetary and galactic exploration missions of the future will involve very long duration flight times, high velocity requirements and onboard power sources. Studies have indicated that ion thrusters offer a viable solution to meet these requirements. Therefore, necessary research and development in this area needs to be accomplished and a strong NASA program to develop Solar Electric Propulsion Systems for planetary exploration and power utilization is advocated. The currently identified Solar Electric Propulsion System (SEPS) and Ion Auxiliary Propulsion System (IAPS) programs need continued strong support.

3. In light of the current funding, facility and personnel constraints on NASA's energy activities, the degree and nature of NASA's involvement in energy areas requires investigation and resolution. The Energy Subcommittee offered the following specific recommendations:

   - o NASA should not choose to phase out of energy work if they can be of value to the country via support to the Department of Energy (DOE). They should seek to carry out specific energy activities that utilize NASA expertise to accomplish technical advancements in programs that provide NASA with appropriate responsibilities and authority.

   - o NASA management should meet as soon as possible with DOE to clarify roles.

4. There has always been a problem in getting advanced technology from the developer to the Program Manager who could use it. This issue was raised again by both the Systems and Electronic Subcommittees. The problem could be due to the reluctance or lack of incentive of the Program Managers to use new technology when older, but qualified hardware exists; or it could be because the new technology has not been proven to the user's satisfaction. It was agreed that the problem cannot be solved by the working level people. This issue requires strong attention at the management level, where agreement must be reached on determining the point where OAST R&D is complete and the technology is suitable for program application. At this point, specific funding should be made available to the Program Manager to account for his concern over potential cost risks to his program.

5. The Electronics Subcommittee reviewing the area of automation felt that too little effort was planned in this area where a potential for large-scale cost savings may be realized. This area is very much in need of definition as to what priority tasks and actions need to be undertaken. Some outside help in establishing this definition is recommended. Once defined, a significant increase in funding and an appropriate increase in internal NASA staffing should occur.

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July 6, 1981

Honorable James M. Beggs
Administrator
National Aeronautics and
Space Administration
Washington, DC 20546

Dear Mr. Beggs:

Based on the findings of the National Research Council's (NRC) study, Improving Aircraft Safety, Robert G. Loewy, Chairman of the NASA Advisory Council's (NAC) Aeronautics Advisory Committee, identified an opportunity for the Federal Aviation Administration (FAA) to use the research resources of NASA in two new ways. First, to assist in maintaining and developing FAA aircraft airworthiness personnel capabilities and, second, in building an adequate technological base for use in certifying aircraft with advanced technology. Specifically, Bob's proposal would co-locate FAA personnel assigned to projects defined and funded by FAA at NASA field centers much in the same manner as the Army has done in the rotary wing area. By this means, the FAA would derive the benefit of having people at a modern research establishment and avoid having to use its limited resources to develop facilities and a "critical mass" of disciplinary expertise such as already exist within NASA. This would also help assure - at the working level - that NASA gives appropriate attention and priority to FAA needs within its own programs. It should help the FAA attract and retain good personnel because of the opportunity to work with NASA personnel at the forefront of technology. The Army/NASA partnership on rotary wing, VTOL and STOL research demonstrates that this concept can work effectively.

Bob's proposal (see the enclosed report) was endorsed by the Advisory Council's Executive Subcommittee with the support of Advisory Council members associated with the commercial aircraft industry. The proposal has also been shown to H. Guyford Stever, who chaired the ASEB study on NASA's role in aeronautics; George M. Low, who chaired the NRC Review of the FAA's Certification Role; and Raymond L. Bisplinghoff, who, following a study he did of the DC-10 accident at the request of Langhorne M. Bond, then FAA Administrator, had made a different proposal to John McLucas aimed at the same objectives. All are in general agreement with the proposal. The Council recommends that NASA's senior management

evaluate this proposal and, if they are sufficiently interested, consider at the earliest apropriate opportunity how it might best be pursued with the FAA's new senior management. Bob Loewy, Guy Stever and I would be happy to discuss the matter further, if you feel that it would be helpful. George Low has offered his assistance as well.

Sincerely,

William A. Nierenberg

William A. Nierenberg
Chairman, NASA Advisory Council

Enclosure

Position Paper

NASA Advisory Council

A NEW ROLE FOR NASA VIS A VIS THE FAA

A study of the FAA was recently conducted under the auspices of the National Research Council. That study led to a report titled "Improving Aircraft Safety" and its recommendations are now under review by the FAA. The NRC report deals only with the FAA's aircraft certification procedures and capabilities - ie "airworthiness" - and excludes any consideration of air traffic control, navigation or pilot training. The report cites a number of ways in which the good record of the FAA in certifying airplane airworthiness can be made still better and lists steps that could be taken to assure the continuation of present safety levels and potentially improve them.

This proposal addresses two important recommendations contained in the NRC report and suggests how NASA might substantially improve its support of the FAA in its mission. The first deals with problems the FAA has had in attracting, developing and/or retaining personnel with the necessary engineering expertise to assess airworthiness. These problems are discussed in excerpts from the report which are attached to this paper (pages 24 and 28). The second recommendation concerns the responsibility that the FAA has in judging compliance with and writing airworthiness rules and regulations and preparing responses to certification submittals. All such actions should be compatible with and not inhibit the use of advancing technology. It should not be assumed that new rules and regulations are a necessary concommitant with the introduction of new technologies; however, rules and regulations may easily become obsolete and must accommodate the introduction of new technologies when aircraft using those technologies are presented for certification as public carriers. Parts of the "Improving Aircraft Safety" report pertinent to this matter have also been excerpted and are enclosed (pages 36 through 40).

Experience with programs of science and engineering in large government organizations (Air Force, Army, Navy and NASA) shows that keeping personnel competent and keeping specifications current are <u>both</u> crucially dependent on having active programs of research conducted by or for the organization in question. The same is true as regards the proper interpretation of their regulations by the FAA with the advent of new technology.

The basic reason an ongoing program of agency research is needed is that before standards or specifications of any merit can be written or regulations properly interpreted, a data base must exist to support their validity in advance of extensive service experience. Such a data base can only be assembled after a substantial program of research - including testing - requiring a significant period of time. Furthermore, with each passing year there are more intriguing avenues of research to pursue than can possibly be fully supported. It follows that those who need the research output must have a substantial say in defining, and the opportunity to participate in or follow, the research

that is done. Furthermore, by actually being able to participate in research aimed at providing a certification base, problems of information transfer both in understanding and timing are avoided. It is important to note that focused research in support of certification needs will need to be funded by the FAA as suggested in the "Improving Aircraft Safety" report, whoever accomplishes the work.

Participation in a research program also acts as a magnet for bright, young, ambitious people. They know that involvement in such activities builds a strong base for a professional career within an advanced technology community, that it provides the kind of associations from which a young person can continue to learn over many years and that it provides opportunities to produce results which often attract wide-spread attention in the field. These values are further enhanced if the conducted research is imbedded in a broader, but related, research program.

It seems clear that for the FAA to solve the crucial personnel problems mentioned above and to develop a substantial part of the data base needed for creative certification, the FAA should participate in or have ready access to a much larger program of research than it now has. It should be noted that the FAA presently conducts a very substantial research program supporting the development of the air traffic control and navigation systems which are essential to our airways network. The FAA research program devoted to aircraft, however, is almost negligibly small. The budgetary constraints under which almost every federal agency operates these days almost certainly precludes the FAA from being able to assemble the facilities and personnel required to quickly move its airworthiness team into the new technology realm. A proper research program to improve competence for assessing airworthiness would involve programs in materials and structures, controls, handling qualities, propulsion, human factors, among others. Even if it were possible for the FAA to build-up its capabilities to do this research in-house, it would be unwise, since applicable facilities and competent research scientists are already available at NASA research centers. The FAA should be able to make use of both NASA's aeronautics facilities and its expertise.

This concept has been discussed with DOT and FAA management people during several previous FAA reviews by outside evaluation teams. The reaction is uniformly that what is proposed is being done and has been done for some time. Furthermore, it is asserted that the FAA draws fully on other agencies; not only NASA but the Air Force, universities and industry. These discussions indicate that those within the FAA who could help develop that agency's aircraft safety research program don't recognize the need or are reluctant to rely heavily on any one agency outside the FAA.

Much research is now being done at NASA which benefits the FAA. Much more could be done but is not being pursued, either because no one has asked NASA to do it, because NASA doesn't have the funds to do it, or because such work has lower priority within NASA than other aeronautics research which has been programmed. In any event, just having another agency do the FAA's work is not likely to improve FAA's personnel situation, and heroic efforts would be required to insure that FAA's priorities and schedules were reflected in NASA funded programs. Certain key people within the FAA must be continuously, intimately responsible for ongoing research. To achieve this the FAA might do what the United States Army has done. The Army has established research offices in each of the three principle NASA aeronautics centers (Ames, Langley and Lewis). In doing this the Army has joined NASA as a partner and the combined group has become a strong force supporting rotary

wing developments. By having co-located offices, NASA & Army people work closely together and use NASA's facilities so extensively that visiting any of the three aeronautics centers to speak about helicopter research, it is difficult to know whether the engineer you're speaking to is a NASA or an Army person.

The FAA might well do something similar. It could plan and maintain complete control over it's program conducted at NASA centers with the help of NASA personnel, through budget allocations. The co-location would insure that FAA offices at the NASA centers could have all the advantages of a modern research establishment in terms of attracting bright young people, and learning from the more experienced NASA personnel while developing a broader disciplinary base for evaluating the compliance of designs to airworthiness regulations. The day to day working relationships developed through actual participation in the research would allow the FAA people to keep the joint NASA-FAA programs closely directed to the objectives of increasing flight safety for commercial aircraft.

It will take a diplomatic approach to the new FAA leadership to bring something like this into being. The role of NASA vis a vis FAA responsibilities must be circumscribed, and obviously so, at all times. At some point knowledgeable people in the Army could be brought into the discussion to indicate how they have achieved their currently successful working relationships with NASA.

The effort seems worthwhile. If FAA could work with NASA, utilizing its aeronautics facilities and capabilities, it would accomplish the airworthiness side of its mission more effectively and be in a better positon to deal with accelerating technologies on the basis of sound knowledge. NASA would also be increasing its major services to the nation. In fact, the new working relationship with the FAA could be an important influence on NASA's plans for an expanding role in aeronautics to meet the challenges of commercial aviation in the United States. In this regard, it should be noted that this entire proposal is completely in keeping with the results of the ASEB's report on "NASA's Role in Aeronautics" following the NRC workshop at Woods Hole, Massachusetts in the summer of 1980.

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

FEB 22 1982

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

In response to the Committee's direction in House Report 97-1257, authorizing appropriations to the National Aeronautics and Space Administration for FY 1982, I enclose a report entitled, "Private Sector Involvement in the NASA Technology Utilization Program."

Please let me know if NASA can be of further assistance in regard to this important program.

Sincerely,

James M. Beggs
Administrator

Enclosure

cc:
Honorable Larry Winn, Jr.

Private Sector Involvement in the NASA Technology Utilization Program

A Report to the
Committee on Science and Technology
U.S. House of Representatives
and to the
Committee on Commerce, Science, and Transportation
U.S. Senate

Prepared by the
National Aeronautics and Space Administration

Washington, DC
February 1982

Outline of Report

1. Introduction

    a. Basis of this Report
    b. NASA Technology Utilization Program Functions
        (1) Objectives
        (2) Basic Elements/Structure of the Technology Utilization Program
    c. Activity Supporting this Report

2. Analytical Framework

    a. The Nature of Commercial Activity
        (1) Profitability
        (2) Continuity of Supply
    b. Technology Utilization as the Business in Question
        (1) Technology Re-use is the Measure
        (2) Information Dissemination Not Equal to Re-Use
    c. When and what will customers pay, for what?

3. Analysis: The potential for further private sector involvement in, and commercialization of, the NASA Technology Utilization program and/or its elements

    a. The acquisition and description of new technology
    b. Screening, abstracting, indexing, storing, and otherwise preparing the New Technology Report for broad dissemination
    c. Preparing and distributing publications, and operating computer-aided information access systems
    d. Brokerage roles: dissemination centers, applications teams, conferences and seminars, and Technology Utilization Offices
    e. Applications engineering, or adaptive development

Conclusions

Bibliography

1. Introduction

a. Basis of this report. The House Committee on Science and Technology, in House Report No. 97-32 accompanying the Bill (H.R. 1257) to authorize FY 1982 appropriations for NASA, and the Senate Committee on Commerce, Science, and Transportation, in Senate Report No. 97-100, accompanying S.1098, the National Aeronautics and Space Act, 1982, requested that NASA "...conduct a thorough review of activities and institutional arrangements in the Technology Utilization program in order to determine which functions of the TU program can be provided by the private sector." NASA was directed to report findings and "a complete assessment of potential impacts on the TU program" to the Committees.

b. NASA TU Program Functions

(1) Objectives. The NASA Technology Utilization (TU) program is designed and conducted to enhance national economic growth and productivity through the transfer of new technology resulting from NASA research and development efforts to the non-aerospace segment of the economy. The program's basis is found in the National Aeronautics and Space Act of 1958, as amended, which requires that NASA "...provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

The Act also provides for:

"...the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in, the utilization of aeronautical and space activities for peaceful and scientific purposes."

(2) The structure and elements of the TU Program. The TU program began in 1962 and over the years, a number of studies, conferences and experimental activities have contributed to the development of the present program elements which are primarily focused on the re-use of NASA-sponsored new technology beyond the aerospace community. The TU program is structured around this central theme of technology transfer and diffusion. The array of technology utilization mechanisms through which NASA helps facilitate the use of aerospace technology in the public and private sectors of the economy, includes:

- Publications and announcement media, designed to acquaint potential users with available technologies emanating from aerospace research and development.

- o A nationwide network of dissemination centers, through which industrial firms and other organizations interested in secondary utilization of technology may avail themselves of NASA scientific, technical and management expertise.

- o A specialized center, at the University of Georgia, which provides aerospace-developed and other government-generated computer programs adaptable to the needs of industry and government agencies.

- o Applications teams, multidisciplinary groups of scientists, engineers and technologists who provide technology-matching and problem-solving assistance to public and private sector organizations.

- o Applications engineering projects, wherein NASA, in cooperation with the private sector, undertakes adaptation of existing aerospace technology to meet specified needs of other government agencies and public sector groups.

- o Technology utilization offices, at NASA field centers, which help would-be users obtain, from NASA's in house and contractor innovators, the greater depth of information about new technology items which frequently is essential in the transfer process. These offices also screen their centers' R&D contracts for new technology, and manage applications projects.

The basic information on NASA's innovations which support these mechanisms is derived through (i) the NASA new technology reporting system, based in the requirement found in section 305(b) of the National Aeronautics and Space Act that new technology developed with NASA support be documented and reported; (ii) NASA's Scientific and Technical Information Facility (STIF) which stores, indexes, abstracts and distributes all NASA in-house and contractor technical reports; (iii) the NASA patent licensing programs and (iv) direct contact, when essential, with field center and contractor engineers and scientists.

c. Activity Supporting this Report.

This report is based upon a review of the history and experience of the NASA TU program, specifically those efforts taken to elicit non-aerospace private and public support for the widespread adaptation and reuse of NASA technology. Material drawn upon includes: program design and cost benefit studies dealing with various of the program's elements; the experience of senior program participants in their efforts to build the user base for TU products and services; and NASA's efforts to induce and elicit private sector participation and support. Other studies and analyses of technology utilization

processes as they function in industry and elsewhere are also considered. Finally, the report analyzes--from the perspectives of program objectives coupled with the profit orientation of the private sector--the opportunities for (as well as disincentives to) private sector commercialization of the NASA TU program either in toto or in part.

2. Analytical Framework

a. The nature of private sector commercialization. For purposes of this review, two major criteria are utilized which any private firm would apply in determining whether it could assume responsibility for NASA's TU program as a commercial venture.

- o First, the requirement for cost recovery and profitability in any private sector venture is paramount. Some private sector or quasi-public institutions can operate on a break-even basis, and some can withstand a few years of negative cash flow while building a business. Successful commercialization, however, requires recapture of investment within a reasonable time frame, a realistic prospect for long-term profitability, commensurate with the costs of the capital investment and operations, all viewed in the light of alternative investment and business opportunities. In examining the TU program from this perspective, alternative sources of public or philanthropic support have not been considered beyond identifying the need for it, and the prospects that it might be available to those seeking to perform NASA TU programs functions with lessened NASA support. In general, our analysis has focused on the marketplace as the basic alternative to NASA appropriations as a source of funding for those activities needed to introduce NASA's new technology into the economy to the "widest practicable and appropriate" degree.

- o Second, a reliable source of "supply" must be available. In this case, there can be no long term "business" of technology transfer unless there is a continuing development of new technologies coupled with availability of adequate and timely information about them. Direct access to the original innovators, in appropriate circumstances, is essential to those innovators who develop secondary applications of the technology. Any commercializing firm reasonably can be expected to give substantial consideration to NASA's prospects for future new technological developments, and their accessibility, before investing its own resources to any appreciable degree. Thus, the business of technology transfer, public

or private, must be based upon the premise that the flow of new technology will continue, and that information concerning these developments will be readily available for dissemination.

b. An additional consideration incorporated in this study is the fact that technology utilization and technical information dissemination are not synonymous. The aim of the Technology Utilization program is the re-use of technology that results from NASA's R&D programs; its application, not information about it, is the ultimate objective. The distinction between TU and information dissemination is important. Experience and research indicates that when information dissemination services are treated as products in themselves and are subjected to profitability tests on an individual basis, technology utilization declines. However, the question of whether or not it could be commercially profitable to sell particular TU program services (such as Tech Briefs) independent of the larger context of technology re-use is nevertheless examined.

c. When and what will customers pay, for what? The requirement for re-use of technology as "The Measure" of success of NASA's TU program leads to a third major consideration that also helps frame the analysis. From the technology re-user's perspective (the customer's viewpoint), when is payment justifiable, and for what?

This analytical framework allows us to look at the question of private sector involvement in terms of an enlighted, entrepreneurial businessman, asking: How might I gain sufficient revenues to cover costs and return a profit from performing services that lead to widespread re-use of NASA technology?

3. Analysis: The potential for increased private sector participation in and commercialization of the NASA TU program. This analysis deals with the various elements of the program individually and in combination with other closely-related elements.

a. The acquisition and documentation of new technology: identifying new technology items, describing them in recorded form, and reporting them to a central repository. The basic NASA aeronautics and space program objectives require the reporting of innovations both for program technical management as well as for new technology identification purposes. Such reporting is also required for planning new technical efforts, for information dissemination among researchers in parallel and sequentially-related R&D projects, and to satisfy non-TU public awareness requirements of the National Aeronautics and Space Act. The primary documentation of these innovations is

provided by the most knowledgeable persons--the actual performers of the original work. NASA provides for this documentation in the form of New Technology Reports (NTRs), 80% of which are the result of contractor efforts. The interruption, and potential for disruption, of NASA mission R&D activities by having a third party record and report on these innovations would not appear to be efficient or wise. In addition, the present system also provides a slight commercial edge to any innovative private sector firm considering the commercialization of a NASA-sponsored innovation. That is, given an adequate market and financing environment, the innovator will be ahead of possible competitors in two key areas: timely awareness of the innovation, and technical know-how. Thus, we conclude that the present system for preparing NTR's is more practicable and efficient than any known alternative. This conclusion is reinforced by the fact that the subsequent elements of the program--especially the assessing and brokering phases--are heavily dependent on the quality of NTRs, and on their continued flow. This points to the need for continued excellence in the management of the NTR's scientific and technological content.

b. Screening, Abstracting, Indexing, Storing and Otherwise Preparing the New Technology Report Information for Broad Dissemination

These functions currently are performed by either commercial firms or non-profit research institutes under contract to NASA, and are funded jointly under the NASA Technology Utilization and Science and Technology Information Programs. These activities are based on the contractor-operated NASA Scientific and Technical Information Facility (STIF) which also performs this same range of services for scientific and technical information required for NASA program management needs. The products of these activities are essential to subsequent technology utilization activities. From the perspective of private sector profitability, the costs associated with this set of activities must be supported either by the technology producer (NASA) or some philanthropic source, or they must be added to the base costs of subsequent TU activities--and the TU services must then be priced to achieve cost recapture. It is significant that the industry-oriented IIT Research Institute (ITTRI) which for many years was under contract to assess NTRs for their commercial potential, never proposed or attempted to build a generally-available commercial service, based on this first-hand knowledge. Nor has IITRI's successor contractor, SRI International, taken any steps in that direction. It seems apparent that, on the profitability test, these activities are not amenable to commercialization--even when the private sector performer has the ability to provide the services. Nevertheless, NASA has found it more practical

and efficient to have these activities performed in the private sector, under contract, than by NASA or other Federal agencies. While the general scope of NASA's technology interests is known, and the range within which innovations will occur is somewhat predictable, the rate of flow of NTRs in any particular technical area fluctuates. The NASA-STIF contractor, and the evaluating research institute are able to operate with greater flexibility in the hiring and assignment of individuals with the needed skills and knowledge to adapt to workload fluctuations. Research centers and universities are among the few institutions with which profit-making user organizations will discuss their technology needs and interests--thus providing these organizations with an added perspective for their TU analyses.

To a limited but still significant degree, the Technology Utilization Officers (TUOs) at NASA's field centers are able to perform or contribute to the screening and analysis of NTRs and of other NASA technology development which has not yet been documented, for commercial potential. These individuals are selected, in part, for their knowledge of the work that their centers conduct or manage. Over time, they gain information through a variety of sources, including industrial inquiries, that help them identify prospective alternative and additional uses for their centers' technological advancements. While several former TUOs are now employed in the private sector, there is no evidence to indicate that their present compensation is supportable by their new employers on the basis of revenues generated by the aerospace technology they helped others utilize; rather, they seem to be employed for the wide ranging technical awareness they place at their employer's disposal. NASA has not experimented with the use of contractor personnel to fill the TUO role within any of its field centers. It seems questionable, however, to assume that the employee of a profit-seeking firm could gain the same degree of confidence as have NASA's TUOs with representatives of other, possibly competitive firms. It would also be more difficult and therefore costly--for non-NASA employees to gain the same support of NASA professionals as do the NASA TUOs.

c. Preparing and distributing publications, and operating computer-aided information access systems. Those items identified in the screening process as having commercial or other transfer potential are made the subjects of special efforts to bring knowledge of their existence to the attention of prospective secondary users. The two principle avenues for providing this targeted awareness and accessibility are (1) the TU publications and (2) the computerized literature search and retrieval services of the dissemination centers.

(1) Publications. Once the NTRs have been reviewed for transfer potential, the most promising are given special write-ups for inclusion in the quarterly journal NASA Tech Briefs. Short, attention-getting articles are prepared by a team of technical writers trained and experienced in industrial and commercial technical interests in fields where it appears that the technology could be applied. NASA supports this effort under a contract with Logical Technical Services, Inc. (LTS). Where needed, a backup document referred to as a Technical Support Package (TSP) is prepared to enhance the value of a particular NTR. This is done either at a NASA field center or by LTS. Selected technology summaries appear in an issue of NASA Tech Briefs, and the reader may obtain the more detailed TSPs on those items of interest, by sending either a Reader Service Card, available in NASA Tech Briefs as a tear-out, or a letter request, to the NASA-STIF. The TSP, in turn, provides a basis for direct technical discussions with the innovators (when appropriate) by arrangement with the TUO at the cognizant NASA center of origin. NASA Tech Briefs is sent to a list of 75,000 recipients in government, industry, and universities. Thus, this publication and the supporting TSPs function somewhat like commercial industrial technical journals, the majority of which are: sent free of charge to a "qualified" mailing list; subsidized by their advertisers who are promoting their technology-based products and services; and include Reader Service Cards whereby the reader conveniently may obtain more detailed information about new product or process opportunities. The experience of private sector journals is that free, targeted distribution is essential--advertisers routinely require it of the media they choose, and profitability for all concerned depends on it. In the case of NASA Tech Briefs and its back-up publications and related arrangements for direct user-innovator technical discussions, NASA is the "advertiser" for the purposes of this analogy. The possibilities (i) for fully commercializing NASA Tech Briefs, and (ii) for fully recovering production and distribution costs for this publication and TSPs through sales of subscriptions have been explored. The conclusion continues to be that the present publications program seems to be the most effective way to issue significant printed information to industry on NASA's new technology, for the following reasons. Subscription fees for such journals tend to limit or reduce circulation, and to direct that circulation away from the intended audience. For example, a 1977 canvass of industrial publishers revealed that free distribution directly to the right readership is widely held to be essential in achieving technology utilization objectives.

Charging for such publications has a history of moving them off the desk or reference shelf in the decision-maker's office and onto the shelves of libraries or magazine racks. Thus, the indications are that publication, for sale, would take NASA Tech Briefs out of the TU role. Similarly, commercial publication, for NASA TU objectives, would require full NASA subsidization; otherwise, the publishers would undoubtedly have to supplement income through advertising revenues from other sources, and thus dilute the NASA TU content. It is noteworthy that the 1977 canvass revealed no privately-published technical journal which charged for subscriptions in order to recover its distribution costs: advertisers cover these costs, as well as publication and profits. Considering that NASA Tech Briefs and most TSPs already are written in the private sector (under contract), that NASA Tech Briefs is printed by the Government Printing Office (or, more frequently, by private printing plants under contract to GPO), and that the distribution effort is centered in the private sector contract-operator of NASA's STIF, there would seem to be little additional room, if any, for private sector involvement in this aspect of the TU program.

(2) Computerized literature search and retrieval services. The nationwide network of NASA-sponsored dissemination centers--Industrial Applications Centers, State Technology Applications Centers, and the Computer Software Management Information Center--also serve to target knowledge of the existence of the new aerospace technology to potential users and adapters. All are operated by non-aerospace research institutes or by universities, and thus are either in the private sector or in the non-Federal public sector. To a greater or lesser extent, all offer computerized bibliographic searches of NASA, as well as other technical data bases. These searches are conducted in cooperation with the potential user of the information. Problem definition and search design, report screening and analysis, technical assistance, arrangement of user-innovator discussions, and seminars and workshops are among the dissemination center services which set the context for the literature searches. These brokerage activities are the primary TU services which the dissemination centers offer, and by which the technical data base access activity is integral. The analysis of this form of technical information access is considered in the following section from the perspective of the larger brokerage role which it supports.

d. Brokerage roles: dissemination centers, applications teams, conferences and seminars, and Technology Utilization Offices. The central feature of the NASA Technology Utilization program

is the variety of avenues through which potential secondary users may gain access to NASA's technology. Seven avenues are most significant for identifying promising new technology:

(1) Reader identification of new technology in a NASA publication;
(2) A joint user-dissemination center data base search that identifies the technology;
(3) Dissemination center or NASA TUO staff analysis and anticipation of non-aerospace technology needs and possibly relevant aerospace technology, followed by market-type approaches to the possible user, ranging from direct letters or calls to conferences, seminars, etc.;
(4) Recognition of possible secondary applications by the NASA or NASA-contractor innovator, followed by approaches to prospective users directly or through the market activities in (3), above;
(5) Requests to NASA from other public agencies for technical problem solving assistance based on available aerospace technologies and/or capabilities;
(6) Identification and analysis of public sector needs and aerospace technology relevance by joint public-private sector applications teams, based in research institutes and universities.
(7) Participation by industry in technical conferences and seminars.

Each of these avenues provide for direct discussion about the technology and its possible re-use between knowledgeable technologists and secondary users: as such they are brokerage activities, leading to technical assistance where necessary and appropriate.

Despite the numerous, widely reported successful secondary applications of NASA technology, some technology still is viewed, in much of the non-aerospace sector, as being:

- too complex,
- too expensive, or
-- too remote for particular corporate needs

to have sufficient short range commercial significance to merit serious transfer consideration. To dispel these impressions, and to break through the initial resistance to the new technology for specific applications normally requires a focused effort.

As noted earlier, the NASA Tech Brief publication and the generalized search capabilities of the IACs and STACs serve to attract the attention of the would-be users to innovations which may be of interest. NASA Tech Briefs, with its 75,000 copy circulation, reaches only a fraction of the technology

decision makers who could potentially benefit from what is reported.[11] Further, these awareness services cannot provide sufficient information to permit adoption directly nor can NASA Tech Briefs list more than the most foreseeably promising new technologies. Neither can the TSP, written from the perspective of the technology's first use, expect to address all the technical questions which a secondary user may have about its subject innovation. Therefore, the TU program provides for the establishment of dialogue between aerospace technologists and possible secondary users.

For each potential user reached, brokerage is a more cost-intensive step than information dissemination. It is also a necessary sequel in that it is the step at which the program is able to add the greatest value from the user's perspective. At the same time, it is the step at which potential users begin to invest their own resources in significant amounts: first in the time needed for communication with the brokers; then in the conduct of analyses and evaluation. Private sector involvement in the brokerage role (or step) already is substantial, as is the participation of the non-Federal public sector. Virtually all of the NASA employee effort in these activities is directed toward providing the detailed information on the technology which is specifically needed and requested by the prospective users, or which is necessary in a conference setting to promote effective user consideration. Even the application teams--which deal primarily with societal needs for which the major services and response roles are played by the public and non-profit sectors--attract participation and investment from profit seeking private firms. At least 36 manufacturing firms have taken part in the projects of the Biomedical Applications teams, alone. The new products developed or adapted as a result of the efforts of these teams become commercially available through the private marketplace, and new or improved services are provided through the existing service-delivery institutions.

In looking at the possibility for still greater private sector participation, several factors stand out.

- The process of brokerage involves discussion of the users' needs and problems, and prospective industrial users are more likely to engage in such discussions with university, government R&D agency, or non-profit institute personnel than with other profit-seeking firms. Confidentiality and trust, in a non-competitive setting, are essential at this stage if there is to be open and candid exploration of user needs and possible new technological responses. The present focus of the brokerage activity in universities, research institutes, and the non-profit setting, with technical assistance available from NASA, seems to provide an optimum forum for private sector participation.

- Engagement in discussions with the broker constitutes, in itself, a new level of resource commitment by the prospective user. It is as a result of this interaction that the user is able to estimate long range costs and benefits. User participation at this stage is speculative. The technology brokers therefore cannot expect to be able to recover the full costs of their efforts from the prospective customer: at least, not in the short-term. As in the industrial sector, the product supplier (NASA, in this case), or a beneficiary third-party, must support the brokerage role.

- Other interested parties, especially several States concerned with economic development of industry and the improvement of public services within their jurisdiction have joined with NASA to support the dissemination centers; and agencies with substantive responsibilities for public services have contributed support to the applications teams. Even if the prospects for greater private sector participation in the brokerage efforts are unlikely, the possibility for greater cost-sharing and involvement on the part of other public agencies may warrant continued emphasis.

- Reliance on greater user and other public agency funding carries with it the possibility, especially in times of economic stress, that the immediate needs of these institutions will be in conflict with important long-range technological objectives. The risk that accompanies such reliance is, that such support will not be available when needed. This points to the possibility of reversion to the situation which preceded the establishment of the NASA TU program. With the brokerage and related engineering left wholly to the profit-seeking sector and the user community, fewer instances of the matching of NASA technology to public sector needs could be expected. Adaptive engineering projects would be fewer and farther between. The time lag between the basic innovation and the realization of its benefits through transfer might well lengthen again into decades, and thus adversely affect the lives of millions of people. Governmentally-subsidized technological advances in other industrial nations would thus achieve an even further economic advantage over U.S. industry.

- Brokerage, including adaptive engineering, accelerates awareness and eventual transfer, points to the non-obvious opportunities, and promotes dialogue. It serves as a constant reminder of possibilities beyond present technical capacities and traditional responses. It differs from the practice of the consulting engineer in its primary reliance on innovative R&D, rather than on proven engineering

practice. It differs from the handful of R&D consultants in that it draws on a wider range of technology, and in its availability to a wider range of users, as well as its emphasis on establishing dialogue at earlier stages of user consideration. Nevertheless, private-sector engineering and R&D consultants, like all other private sector enterprises, can (and do) draw on the NASA TU brokerage resources in their searches for new technology to meet their needs.

- Examples can be found of particular sets of NASA technology which might be of sufficiently obvious widespread value that they could be brokered at a profit. It appears that some brokerage activities of the dissemination centers may now be paying their own way, or nearly so. To segment these into separate, short-term profit-oriented packages would appear either: (a) to add to the need for subsidy for the remainder, or (b) to narrow the scope of the TU program -- depending on whether existing dissemination efforts were otherwise continued, or were discontinued. In the latter case, it appears that the NASA technological base which actually is used secondarily would be narrowed; as would the range of secondary users and third-party beneficiaries. In most cases, it appears that brokerage services and products simply must consume too much professional-level service under speculative conditions to allow full, direct recovery in conventional short-range pricing terms.

- The dissemination centers are encouraged to develop alternative sources of revenue consistent with their role in promoting the widespread accessibility to, and reuse of, NASA technology. Their market experience has led to the present pragmatic balance of funding from the broker the user, and prospective third-party beneficiaries (or their representatives).

- NASA continues to explore new approaches to technology transfer. Since 1979, it has cooperated with the American Institute of Aeronautics and Astronautics (AIAA) to introduce leading non-aerospace R&D executives to NASA's technologists in those fields most likely to benefit the participating firms. As a series of quarterly seminars, rotating among the NASA field centers, these will be continued so long as the meetings are mutually beneficial. AIAA coordinates all of the industry participation with industry reimbursement. NASA funds only the costs of NASA employee participation.

- The brokerage activities--for which NASA supplies the technology, supporting information, and partial funding--are supported by NASA for the purpose of promoting

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secondary uses of NASA technology. The NASA-supported brokers, however, are able to go beyond the NASA-supported role in their provision of goods and services to the non-aerospace sector. Some might well be able to serve as technology or, at least, technical information brokerage institutions without NASA support. The possibility of their continuation under such conditions as effective arms of the NASA TU program is not established. Severed from the responsibility to provide services for NASA, and unsupported by incentives to do so, the focus of these brokerage activities should be expected to shift away from NASA technology.

e. Applications engineering, or adaptive development. The connecting function between a technology in one setting and its use in another field is the adaptive design, development and test of the technology, and its demonstration in the new setting. NASA has supported this effort for the past decade in order to provide new technology to meet widely recognized public needs. Most applications engineering projects result from the identification and analysis of needs and opportunities on the part of the NASA-sponsored application teams and TU specialists. These teams normally remain involved throughout the adaptive engineering and demonstration phases, for guidance and evaluation purposes. In virtually all cases, private sector firms have been engaged, after competitive contracting, to conduct the development and test efforts and, to varying degrees, have shared in the costs of the projects. Willingness and ability to provide the new product on the open market has been a criterion for contractor selection. To a degree, these developments function as joint ventures, with the public sector providing risk capital for market definition and some product development, in return for the public benefits expected. The open opportunity for greater private sector involvement hinges on tax and related economic policies which would encourage a greater volume of high-risk new or adaptive development to meet the same range of needs which these projects have addressed. The other alternative to NASA support is greater financing by those public agencies at either the Federal or state level which have governmental responsibility for the sectors which will be served by the adaptation of NASA technology: public health and safety, opportunity for the physically handicapped or limited, surface transportation, etc.. Even then, however, it appears that NASA would have to continue to be involved in new adaptation -- as the needed authoritative source and interpretor of information on its available new technologies.

CONCLUSIONS

1. The private sector currently functions as a vital and necessary team member of the NASA TU program and is involved in each phase of the operations of the TU program.

   - o About 80% of all NASA innovations result from contractor efforts;
   - o The primary documentation of those innovations (New Technology Reports) are prepared by the performers of the work;
   - o The central information system for storage and distribution of the technology reports is operated by a commercial firm;
   - o Publications targeted to stimulate broad awareness of innovations are prepared by a commercial firm;
   - o Brokerage activities, including
     - operation of three of the industrial applications centers
     - conducting, supporting and participating in seminars and conferences, and
     - sharing in the work and expenses of the targeted technology applications teams;
   - o involve commercial firms, non-profits, universities, technical societies, and industry associations;
   - o The private sector commercializes the innovation(s).

   Table I outlines this involvement in greater detail.

2. These program phases, are interdependent.

3. As a general rule, commercial firms appear willing to commit their resources to an increasing degree as the proof-of-concept and commercialization stages are approached; specifically those activities which are focused toward direct applications of the technology and allow commercial firms to participate and invest selectively, are favored. The precursor functions do not appear to provide the basis for a reasonable private sector investment opportunity and therefore have required support from public sources. Significant private sector investments thus tend to be first made at the point of brokerage negotiations.

4. Within the private sector, profit-seeking firms are, for obvious reasons, reluctant to discuss new technology needs or interests with potential competitors. Thus, the brokerage role seems to require the confidentiality and neutrality afforded by private non-profit and public agencies.

5. Several of the non-revenue producing activities that are central to the TU program have been found to be best performed by private sector firms, both profit-seeking and non-profit, under contract to NASA.

6. Charging for detailed technical publications which report on physical properties or processes, is possible, and NASA does so to the maximum extent possible. Thus, the private sector is willing to pay for information, but appears to be more willing to pay for product development and marketing activities <u>after</u> it has found a product concept of interest.

7. Table II outlines presently apparent alternatives to the current form of reliance on private sector participation in the various functions of the TU program, and summarizes the potential impact on the TU program's objectives of adopting each alternative.

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National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

APR 1 1982

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Enclosed please find NASA's response to the Committee's request pertaining to the National Oceanic Satellite System (NOSS) as defined in House Report 97-32 to accompany H.R. 1257, authorizing appropriations to the National Aeronautics and Space Administration for Fiscal Year 1982.

"The Committee requests that NASA reassess the implications and significance of the National Oceanic Satellite System concept. The Committee further requests that NASA investigate institutional arrangements for such a system which would replace the previous tri-agency arrangement. Finally, any ocean surveillance system developed by the Department of Defense should include a mechanism for providing data to the civilian community."

Please let me know if NASA can provide further information on this subject.

Sincerely,

James M. Beggs
Administrator

Enclosure

cc:
Honorable Larry Winn, Jr.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON, DC 20546

Report Prepared in Response to

House of Representatives Report No. 97-32
Committee on Science and Technology

March 1982

We agree with the Committee that benefits of remote sensing of the ocean from space have yet to be fully evaluated and recognized. We, too, believe that Seasat has demonstrated that satellite provision of global ocean conditions on a timely basis can improve the efficiency of marine operations. We concur with the Committee in feeling that there are other benefits yet to be explored. We appreciate the severe limitation of existing and planned meteorological satellites for measuring characteristics of the ocean and their inability to provide needed synoptic global observations for the oceans.

In reassessing the implications and significance of the NOSS concept, we would like to point out that what we originally proposed to do is still valid. There remains the need for both a second or backup satellite and a real-time ground data system. The second satellite is required to provide a sufficiently long period for user demonstration, as well as to avoid problems such as experienced by the early failure of Seasat; the ground system is required to provide users the data in a useful form and a timely manner. Without both of these, it will not be possible to conduct operational demonstrations for global ocean remote sensing, the central concept of NOSS.

With the demise of NOSS, we in NASA will continue to vigorously pursue our research program in satellite oceanography; however, it will essentially be a single-agency program, able to stand alone. Although coordinated with other agencies (eg. Navy and NOAA), it will not be dependent on them for funding, thus avoiding complicating institutional arrangements.

Concerning the Committee's desire for data from DoD satellite systems being accessible to the civilian community, we are interested in selected data sets from certain DoD spacecraft, such as noted below. We--in concert with our working-level DoD colleagues--are in an initial stage of defining our requirements for same. Until this has been accomplished, we feel it most appropriate to defer further comment on this question.

We would like to take this opportunity to comment on our overall research program in satellite oceanography. Its goal will continue to be focused on evaluating the utility of spaceborne techniques for observing the oceans and applying these techniques in advancing our understanding of the fundamental behavior of the oceans. In order to minimize total program cost, we are concentrating on those satellite ocean sensors with the greatest near-term potential for contributing to our understanding of the fundamental behavior of the oceans. Moreover, we are looking at various flight options for those sensors, either aboard a

dedicated spacecraft if so constrained by deployment requirements, or aboard spacecraft-of-opportunity if deployment requirements are minimal.

Thus, we are studying a dedicated spacecraft for the altimeter, where a 1300-km altitude, a 1-km repeat ground track, and a 63° inclination orbit are required. The project involving this spacecraft has been designated the Ocean Topography Experiment (TOPEX) and is focused on the determination of the general circulation (or current structure) of the global oceans. Not only will an improved understanding of the oceanic circulation and the associated redistribution of heat help assess the influence of the oceans on atmospheric climate, but information on the global wind and wave field will be useful to operational users. In FY-1983 we are planning to implement breadboarding activities related to reduction of technical risk, specificaly covering the altimeter itself and an advanced radiometric tracking system.

We are also studying the feasibility of deploying a scatterometer and/or a color scanner aboard the NOAA series of operational meteorological spacecraft. The scatterometer, which maps the surface wind field, will contribute to the TOPEX objective; the color scanner, which maps chlorophyll concentration associated with phytoplankton, can contribute to our understanding of primary productivity in the oceans. Information from these two sensors, respectively, can potentially contribute to atmospheric weather forecasting and fisheries management. In FY-1983 we will be conducting design studies for both sensors.

For data from other sensors, we are looking to non-NASA sources. For example, we are investigating the scientific needs for data from the Air Force's microwave radiometer (the SSMI) aboard the Defense Meteorological Satellite Program (DMSP) series of operational meteorological satellites, scheduled for launch in 1984; and from the Navy's altimeter aboard Geosat, scheduled for 1984. We are conducting preliminary discussions with (1) the European Space Agency regarding having access to data from the synthetic aperture radar (SAR), scatterometer, and altimeter aboard their ERS-1 spacecraft, scheduled for launch in 1987, (2) the Canadians regarding the SAR aboard their Radarsat, scheduled for 1990, (3) the Japanese regarding data from their MOS-1, scheduled for 1985. Moreover, we are exploring options for deployment of ocean sensors aboard ERS-1 and/or Radarsat. In FY-1983 we will be conducting conceptual studies defining options for having access to these various data sources.

We feel that we can pursue a viable research program given our planning for the dedicated deployment of the TOPEX altimetric spacecraft and piggyback deployments of a scatterometer and color scanner, and assuming that we can negotiate access to other sources of ocean data as noted above. With this program it will not be possible to conduct a NOSS-type of operational demonstration. Data will be coming from multiple sources and will be available only in non-real time. However, retroactive demonstrations for limited regions and short periods of time could be performed.

Table I
Current Private Sector Involvement in NASA TU Program

FUNCTION	PRIVATE SECTOR INVOLVEMENT	FUNDING SOURCE
New Technology Report	About 80% written in private sector, by NASA contractors	NASA R&D Programs which fund the Contracts
Screening and Analysis for Commercial Potential	Performed by a non-profit, research institute	NASA TU Program
Central Technical Information Reporting and Distribution Center	Operated by a commercial firm	NASA TU Program, building on the base of effort required of the same contractor for support of NASA's, and its contractors', S&T information needs
Preparation of Awareness Publications	Performed by a commercial firm	NASA TU Program
Publication Distribution	Purchase "Saleable" Publications	NASA TU Program and Purchasers
Nationwide Network of Regional Dissemination Centers	Two centers are operated by private universities; two are operated by non-profit foundations. (The remainder are operated by public universities)	User fees; third-party support (other Federal agencies and non-Federal public sources); NASA TU Program provides base support
Seminars and Conferences	Technical Societies, Industry Associations	Fees from registrants; society or association guarantees; NASA provides participants, and may provide meeting sites, at own expense
Applications Teams	Located in private and public universities and in non-profit research institutes. Profit-seeking firms are involved as potential commercializers of resulting new product or service concepts	Private sector firms generally pay their own way; NASA and other interested public agencies support the rest of the operation

FUNCTION	PRIVATE SECTOR INVOLVEMENT	FUNDING SOURCE
Engineering Applications	(a) Carried out by private sector firms which will market the new products or services, under contract	(a) Joint support among NASA, other public agencies, and the private sector participant. Relative levels negotiated, case-by-case
	(b) Carried out by private sector firms on their own.	(b) The commercializing firm

Table II
NASA TU Program - Alternatives and their Impacts

FUNCTION	ALTERNATIVES	POTENTIAL IMPACT
New Technology Reports (from Contractors)	None Apparent	-----
Screening and Analysis for Commercial Potential (by SRI International)	None Apparent	-----
Central Technical Information Repository and Distribution Center	None Apparent	-----
Preparation of Awareness Publications, and Publications Distribution	Sell Subscriptions to Tech Briefs, shifting cost burden to private sector	Might detract from value as a TU mechanism; could require change in content and produce change in readership
Dissemination Centers Netowrk	Withdraw Federal Support; leave to users and interested third parties to continue	Would weaken linkage to NASA technology; could weaken the services provided and, if so, would weaken user-charge income; third party support would appear to be crucial to survival
Seminars and Conferences	Rely more heavily on professional society and industry association support	No cost savings to NASA, unless associations were to reimburse NASA for its participation. Otherwise, a promising avenue for continued exploration
Applications Teams	Withdraw NASA financial support; leave to agencies and commercial participants	NASA technical assistance still would be required; availability of alternative resources not proven, would have to be negotiated, case-by-case. NASA fund cutoff without replacement support would eliminate the teams

FUNCTION	ALTERNATIVES	POTENTIAL IMPACT
Engineering Applications	Withdraw NASA support; leave to private sector or to other public agencies	Will reduce and/or delay secondary uses of NASA technology; unless other public sector funding (e.g., from health agencies) is substituted, will delay the applications of technologies that could extend the lives and capabilities of large numbers of people

PRIVATE SECTOR INVOLVEMENT IN THE NASA TECHNOLOGY TRANSFER PROGRAM

A Report to the

Committee on Science and Technology

U.S. House of Representatives

and to the

Committee on Commerce, Science, and Transportation

U.S. Senate

Pursuant to Requests of the Committees

in House Report No. 97-32

and in Senate Report No. 97-100

Prepared by the

National Aeronautics and Space Adminstration

Washington, DC

April, 1982

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1.0 INTRODUCTION

1.1 Purpose

The House Committee on Science and Technology, and the Senate Committee on Commerce, Science, and Transportation,* stated that NASA should:

> "...make every effort to encourage the private sector to assume more responsibility for funding and facilitating transfer of remote sensing technology."

Additionally, House Report 97-32 requested NASA to:

> "make a thorough review of areas applicable to transfer to the private sector, assess mechanisms for this transfer and report findings and progress toward achieving these goals..."

This report responds to the Committees' direction and presents the results of the requested review of NASA's Technology Transfer Program.

1.2 Program Background

The NASA Technology Transfer Program is designed and conducted to ensure that the public and private sectors derive maximum possible benefits from NASA developed space applications technology, thus maximizing the return on Federal investment in the technology. The mandate for the involvement of NASA in Technology Transfer is found in the Space Act of 1958, as amended, which requires that NASA:

> "...provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

The Act also stipulates that NASA should undertake:

> "...the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in, the utilization of aeronautical and space activities for peaceful and scientific purposes."

NASA responded to the Space Act mandate by establishing the Technology Transfer Program during the early development of the Earth Resources Technology Satellite Program in 1973. The objectives of the Technology Transfer Program are to:

- Determine and understand user needs and priorities
- Identify new opportunities and potential uses of space technology and data

* In House Report No. 97-32 accompanying the Bill (H.R. 1257) to authorize FY 1982 appropriations for NASA and Senate Report No. 97-100 accompanying S.1098, the National Aeronautics and Space Act, 1982.

- o Stimulate and implement cooperative programs to develop, test, and evaluate those uses
- o Develop an independent national university-based capability to conduct research and to advance space applications
- o Disseminate the results of NASA's technology activities to the private and public sector
- o Utilize feedback from the user community for improvement and planning of new space applications technology programs

Since the implementation of the Stevenson-Wydler Technology Innovation Act of 1980, the Technology Transfer Program has also been a major NASA mechanism in fulfilling the agency requirements to transfer technology to state and local governments and the private sector as specified in Section 11(c) of P.L. 96-480.

Since its inception in 1973, the Technology Transfer Program has been carried out by the User Affairs Division in the Office of Applications from 1973 until 1977; the Technology Transfer Division in the Office of Space and Terrestrial Applications from 1977 to 1981, and is presently the responsibility of the Earth and Planetary Exploration Division in the Office of Space Science and Applications as of the NASA reorganization effective December 3, 1981. As part of the agency's overall budget reductions, the NASA Technology Transfer Program is being funded at a reduced level of $5.0M in FY 1982 and is planned for phase-out in FY 1983 with the exception of the University Applications program area. University Applications will continue to be funded at a reduced level of $2.8M in FY 1983.

1.3 Approach

In response to the Committees' request, a study has been performed to identify areas of the Technology Transfer Program suitable for transitioning to the private sector and to understand how the private sector might participate to a greater extent in carrying out the transfer of remote sensing technology. The Technology Transfer Program was examined on the basis of its five major programmatic areas: (a) User Requirements Definition; (b) Applications Systems Verification and Test (ASVT); (c) Regional Remote Sensing Applications; (d) Information Dissemination; and (e) University Applications. Each program area was analyzed in terms of its functions, mechanisms, the degree of private industry involvement to date, and the feasibility and practicality of further transition to the private sector.

The feasibility and practicality of transitioning specific activities to the private sector was assessed by considering the open marketplace as a basic alternative to NASA appropriations as a source of funding. In other words, a judgement was made whether each program area possessed a viable market and provided the necessary profitability to be perceived as a reasonable commercial venture. In

addition, assumptions were made that a stream of remote sensing technology and data would continue to be available as a stimulus to the market.

The results of the analysis are presented in Sections 2.0 and 3.0. Section 2.0 presents the nature and degree of present private sector involvement in NASA's Technology Transfer Program. Section 3.0 presents findings regarding the feasibility and practicality of further transition of each Technology Transfer Program area to the private sector. A sample of activities and accomplishments is also presented to adequately describe the nature of the work conducted in each program area.

2.0 PRIVATE SECTOR INVOLVEMENT TO DATE

The private sector presently functions as a vital and necessary team member of the NASA Technology Transfer Program and is involved in each of the program areas. The involvement has normally been either as an end user of remote sensing technology, as a contractor to NASA, or as a member of the value-added services industry.

2.1 Private Sector Users of Remote Sensing Technology

The most extensive users in the private sector of Landsat derived information have been the resource exploration industries - primarily petroleum, natural gas, and mineral exploration. They have maintained a continuous interest in Landsat data, and have continued to independently expand their analysis of the data from photo interpretation techniques to their present use of interactive digital analysis techniques.

The agribusiness industries have been very aware of the Landsat program and the government's R&D efforts in agriculture (i.e., AGRISTARS Program) but have been slow in applying Landsat data their routine resource management requirements. In the forestry industry, there has been limited operational use of Landsat data. A few of the larger corporations, with large land holdings, have conducted in-house R&D and several companies (St. Regis Paper and Weyerhauser) have participated with NASA in test and evaluation projects.

The electric utility industry has expressed strong interest in the use of Landsat data in the context of geobased information systems for watershed management (particularly measurement of snowmelt and water runoff), projecting future power needs through changing land use patterns, planning for power distribution, siting new power plants and transmission corridors, and monitoring and predicting environmental impact resulting from their activities. A limited number of utility companies have used Landsat on an independent basis. In addition, NASA is presently conducting cooperative technology transfer projects with Pacific Gas and Electric and Pennsylvania Power and Light. The results of these projects are being distributed to the entire electric utility community through the Electric Power Research Institute.

Private companies involved in construction, and engineering which require geological, land use planning, or environmental management information have also used Landsat derived information on a limited basis. The larger companies, primarily in engineering and construction, have employed Landsat for geological studies for siting of major construction projects, including railroads, highways, dams, and power plants.

Private industry users have been involved in NASA's Technology Transfer Program in a number of ways. First, a variety of private industries have participated in User Requirements Definition studies to ensure that the needs of private sector users receive appropriate consideration in NASA program planning. Second, specific private companies have participated as cooperating user organizations in joint ASVT projects designed to test and evaluate experimental remote sensing techniques for applications of interest to the private sector. Third, private industry users have participated in NASA's Information Dissemination activities both as contributors and recipients. Fourth, a number of private firms have participated as experimenters of remote sensing technology in cooperation with the universities, funded through NASA's University Applications Program.

2.2 Contractors to NASA

Private companies on contract to NASA's field centers provide a major portion of the technical capability which NASA employs in cooperative ASVT and Regional Applications projects with various users. These contractors also perform NASA sponsored User Requirements Studies and carry out nearly all the Information Dissemination activities such as project reports, newsletters, symposia, workshops and conferences. These companies include Lockheed, General Electric, Computer Science Corporation, Technicolor Graphics, Environmental Systems Research, Battelle Memorial Institute, Environmental Research Institute of Michigan, and OAO Corporation.

On a competitive basis NASA has also involved private value-added services industries as the technical arm in cooperative ASVT and Regional Applications projects. These companies are normally on contract to NASA or the cooperating user organization. The purpose of these tripartite arrangements involving the user organization, a value-added services firm and NASA is to transfer new techniques to a developing remote sensing industry as well as to the user community. In so doing, a multiplier effect is developed which results in broadening the base of remote sensing capability available outside NASA. In several projects, this strategy resulted in the development of a new capability and product line by the value-added private industry as a result of its participation.

2.3 Value Added Remote Sensing Services Industry

There is a growing number of organizations which have entered the business of providing remote sensing analytical services, products, and equipment to satellite remote sensing users. Most of these

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organizations are for-profit businesses, some are private not-for-profit groups and others are university affiliated. Their major business areas include the following:

- o Date Analysis Services - manual and computer implemented analysis, interpretation and conversion of remote sensing data into information products (statistical, graphical and textural) to be used for operational decision-making.

- o Special Purpose, Enhanced Imagery Products - Implementation of any of a number of optical and digital enhancement techniques designed to produce a superior hard copy image for visual interpretation.

- o Data Analysis Equipment - Optically or computer oriented equipment designed for the processing, analysis and interpretation of remote sensing data into information useful for decision-making.

- o Computer Data Analysis Packages - Computer programs designed for the processing, analysis and classification of remote sensing data for a particular purpose or thematic extraction.

The growth of the value-added services industry market has been relatively slow and directed primarily toward the large amalgamated markets represented by the mineral and petroleum industry and foreign governments. To date, the industry has been cautious to implement only well proven, low risk remote sensing techniques such as selected routine land cover applications of the Landsat MultiSpectral Scanner (MSS). The success of the private sector in assuming the Technology Transfer function, will to a large extent, depend on the ability of the value-added industry to expand its services routinely to Federal agencies, state and local governments, and other private users as well as to become involved in higher risk technique development and application.

In the area of user requirements, a number of value-added services firms have independently carried out studies aimed at determining user requirements or potential future markets for remotely sensed data from space. However, in most cases, these studies have been proprietary in nature, and normally for internal corporate marketing purposes or performed under contract for specific customers. In a limited number of cases, private companies such as Metrics, Inc., have completed user needs and market surveys as a commercial venture, and have offered their product in the marketplace.

Much of the information dissemination activity within NASA's Technology Transfer Program, has been directed at the value-added services industry. In addition to the normal information dissemination channels, two open conferences were sponsored by NASA and conducted by the American Institute for Aeronautics and

Astronautics (AIAA) and Battelle Memorial Institute. These conferences resulted in increased two-way communications between industry and NASA concerning their respective roles in the earth resources satellite program and the remote sensing industry's perception of future information needs.

In another area of Information Dissemination, NASA has spun-off its newsletter activity to several small commercial firms which are publishing and distributing newsletters concerning remote sensing as a commerical venture. As a result of NASA's previous involvement in this area, a potential subscriber base was already established. NASA assisted by making available its user distribution lists and provides information concerning status of its remote sensing activities.

3.0 ANALYSIS OF TECHNOLOGY TRANSFER PROGRAM AREAS

3.1 User Requirements Definition

3.1.1 Program Description

The User Requirements program area determines and analyzes user needs; translates these needs into technology requirements such as new data processing and information extraction techniques; identifies new and unproven applications of technology; and obtains user feedback as an input to NASA's program planning through continuing two-way communcations with the user community. To a large extent, the User Requirements program area relies on its interfaces with a breadth of users as a continual pointer and source of direction for NASA's technology applications activities.

The major mechanisms used to accomplish the User Requirements Definition objectives consist of technical studies aimed at determining requirements in a particular discipline or user group as well as on-going cooperative activities with national user representative groups such as the National Governors Association (NGA) and the National Conference of State Legislatures (NCSL), professional associations, societies and institutes, such as the Electric Power Research Institute. The Requirements Definition studies are normally jointly conducted by NASA field centers and technical representatives from the user community. Following is a sample of activities in this program area:

- In support of the Landsat-D new start, a series of studies were initiated to identify the requirements and benefits to be derived from improved earth resources satellite data. These studies consisted of a comprehensive user survey and an intensive analysis of user requirements by four Application Survey Groups comprised of discipline experts in Land Inventory, Inland Water Resources, Agriculture, and Mineral and Petroleum Exploration. One of the significant results

of these studies was the identification by the user community of a pervasive need for a spectral band in the 2.2 micron range for increased effectiveness in geological mapping, and mineral and petroleum exploration. The additional spectral band was subsequently included in the specifications for the Thematic Mapper on Landsat-D.

- In cooperation with NGA and NCSL, NASA established a communications network that included the NCSL Task Force on Remote Sensing and Information Systems, the NGA Earth Resources Data Council (ERDC) and individual representatives from most of the 50 states. These groups worked together to convert the information needs of state governments into program requirements for Landsat-D. The requirements input from these groups were a major factor in the decision to include the Multi-spectral Scanner (MSS) on Landsat-D as well as to develop low cost mini and micro Landsat data processing systems. These two organizations have continued to be focal points for identifying state requirements and incorporating these requirements into such activities such as the Landsat-D Technical Users Working Group, NOAA's Transition Plan for the Civil Operational Land Remote Sensing Satellite System, and Presidentially directed Private Sector Involvement and Integrated Remote Sensing System Studies.

- In cooperation with the Electric Power Research Institute, a requirements assessment was completed of the potential uses of remote sensing from space in forecasting future energy consumption needs and planning distribution networks to meet those needs. This study involved over 60 utility companies and resulted in a pilot ASVT project with Pacific Gas and Electric Company in California to test and evaluate the potential applications.

In summary, user inputs from Requirements Definition studies have been major factors in changes in particular hardware, e.g., restoration of MSS on Landsat-D, new development of hardware such as mini and micro Landsat data processing systems at the NASA Earth Resources Laboratory (ERL), and in-depth analysis of a specific discipline or application area, e.g., power utility planning, for the purpose of identifying candidate areas of emphasis.

3.1.2 Feasibility of Transfer Transition to the Private Sector

User Requirements Definition is an integral part of the development and operation of a resources observation satellite system, as well as the data processing and information extraction techniques which are necessary to effectively apply its output to earth resources management. It provides the

program direction and focus to ensure effective and efficient response to the user community. Some User Requirements activities support the R&D of emerging remote sensing systems while others relate to the routine operation and maintenance of an operational system. In the absence of a system operator, NASA has performed both of these functions. In both cases, the functions were traditionally dependent upon the Technology Transfer Program since it provided the focal point of interface with the user community.

In the future, the conduct of User Requirements activities dealing with operational aspects would be best performed by the organization responsible for operating the U.S. Civil Operational Land Remote Sensing Satellite System. For the interim, the National Oceanic and Atmospheric Administration (NOAA) will be responsible for operating the system. The eventual goal is to commercialize the system and transfer it to the private sector. If the system is to be owned and operated by the private sector, the private owner and operator would require the establishment of strong ties with the user community which would include User Requirements activities. NASA, on the other hand, should continue the User Requirements activities which are necessary to determine the direction for future R&D in land remote sensing, and the test and evaluation of new technologies and techniques resulting from the R&D. Until the Civil Operational Land Remote Sensing Satellite System is fully transferred to the private sector, NASA should also encourage private industry to perform requirements studies in their own key business areas as input to future system planning. Potential forums for such User Requirements Definition activities include private user consortia and industrial associations such as the GEOSAT Committee.

3.2 Applications Systems Verification and Test (ASVT)

3.2.1 Program Description

The ASVT program area assesses the viability of emerging remote sensing techniques through cooperative test and evaluation projects with public and private user organizations in a variety of test environments. The products of an ASVT are scientifically verified techniques, processes or methods for using remote sensing technology in "first time" applications related to specific problems such as monitoring the earth resources, managing water resources, and maintaining the quality of the environment.

The mechanisms used in the ASVT program area consist of cooperative projects with a variety of representative user organizations including Federal agencies, state and local governments, and private industries. Typically, a single ASVT project requires a three year duration to test and evaluate new remote sensing techniques for a particular application. Funding

responsibility is phased so that most of the funding burden is usually carried by NASA in the initial year of the program and increasingly picked up by the cooperating user organization in the later years, as the technology becomes understood and the level of risk defined. By the end of a project, the user will typically contribute approximately 60 percent of the funding and NASA 40 percent.

The identification of candidate ASVT projects results from matches between emerging new technologies or techniques and priority user needs which are identified in the User Requirements Definition Program. For example, the User Requirements study of power utility applications of Landsat resulted in the ASVT project with Pacific Gas and Electric Company. The final selection of ASVT's are primarily based on the following criteria:

- Potential test of new techniques or applications tied to a NASA program priority but not yet evaluated in a representative user setting.
- Convergence of a technical capability and a user need of major importance which is central to a current national problem
- Application to be evaluated is representative of a potentially large scale market and associated socio-economic benefits
- Cooperating user organizations will have a substantive technical involvement and resource commitments in the project

As a sample of project activities, Appendix 1 provides a listing of active and recently completed ASVT's.

3.2.2 Feasibility of Transition to Private Sector

It is unlikely that private industry would attempt to perform the high-risk extensions of technology, and test and evaluation activities representative of the ASVT program area on a profit-making basis. In addition, NASA will continue its role in advanced technology R&D for sensors and data analysis techniques and will require to test and evaluate the R&D results to ensure their relevancy to user needs. As a result, it appears that NASA must continue to be involved in the test and evaluation of high risk technology. The following factors identified during the study support this conclusion:

- Experience in the last 10 years of development in space remote sensing has shown that profit-seeking firms do not expose themselves in a high-risk test and evaluation environment characterized by an unsettled

structure for continued overall system operation, and a lack of guaranteed continuity of data. Presently, private industry perceives space remote sensing as being in an early phase of development and having a highly uncertain future, particularly in regard to the establishment of an operational system.

- Users look upon the test and evaluation of new techniques as an iterative and continuous activity and one that is not compatible to a fixed contractural arrangement between a profit-making industry and a user. Due to the uncertainity of the technology, users seek a transfer mechanism which does not involve constraints often inherent in a profit-seeking venture and that encourages a risk taking mode of investigation.

- The maturity of the user community is an important consideration in determining the feasibility of transferring an ASVT-like test and evaluation activity to the private sector. In the case of land remote sensing, with few exceptions such as the mineral and petroleum industry, the user community is still in the early stages of development and does not represent a substantive market base for private industry.

- Similarly, the value-added remote sensing industry is not yet mature and often is not comprised of the type of companies which have the proper discipline mix to support user needs. Current private sector service capabilities for utilizing Landsat are generally limited to aerospace companies or in some cases information system software firms. Extension to other more traditional user sources of environmental and resource planning data and assistance must occur if established market structures and working relationships with users are to be optimally utilized.

In summary, NASA should maintain responsibility for a ASVT-like test and evaluation activity as an integral part of its R&D in remote sensing. This activity is necessary to evaluate the potential capability of new technology in meeting widely recognized, priority user needs. However, once validated and no longer "high risk", the techniques should be transferred to private industry via cooperative projects, open workshops, and documentation with the intent that industry continue to apply the new technology within the marketplace. Since the NASA FY 1983 Technology Transfer budget does not allow for the continuation of the ASVT program area, private industry will have to rapidly move into higher risk applications of new technology if the technology transfer momentum is to be continued in the area of emerging applications.

3.3 Regional Remote Sensing Applications Program

3.3.1 Program Description

The Regional Remote Sensing Applications Program was established in 1977 in response to recommendations by the General Accounting Office (GAO), National Conference of State Legislatures (NCSL) and the National Academy of Sciences Space Applications Board (SAB) to increase and focus NASA's efforts in technology transfer, particularly to state and local governments. The GAO, NCSL and SAB were concerned that the state and local community was not being addressed by the remote sensing services industry due to its less profitable, lower volume, geographically diffused, and internally oriented market structure. Yet state and local users, as a group, stood to accrue substantive benefits from the use of Landsat in meeting their growing natural resources management responsibilities.

With this in mind, the Regional Applications Program was established to provide state and local governments with a low-risk opportunity to evaluate the capabilities of Landsat. Under this program, responsibilities are concentrated in three NASA field centers that serve as the principal contacts for states in their regions as follows:

- The Ames Research Center, Moffett Field, California, is responsible for dealing with 14 western states including Alaska and Hawaii.
- The Goddard Space Flight Center serves 19 states in the east and northeast plus the Virgin Islands and Puerto Rico.
- The National Space Technology Laboratories Earth Resources Laboratory is responsible for a 17 state region in the midwest, south and southeast.

Regional Applications projects are the key elements of the program, providing state and local governments with opportunities to evaluate data processing and analysis techniques in their own operational settings, and to apply these techniques to their own information needs. These projects are conducted on a cost-shared basis between the users and NASA. The project results provide the basis for decisions to utilize Landsat data on an operational basis, either independently (i.e., in-house) or through services supplied by industry. Twenty-six states have been involved in cooperative Regional Applications projects of which 16 have been completed. Appendix 2 presents a listing of projects, applications addressed and participants in the Regional Program. As a direct result of this program, approximately 15 states have developed capabilities which enable them to routinely use Landsat data in an operational manner.

3.3.2 Feasibility of Transition to Private Sector

States represent a growing community of Landsat data users. A Survey of State Applications of, and Investments in, Landsat Technology published in May, 1981 by the National Conference of State Legislatures (NCSL) and the Council of State Planning Agencies (CSPA) jointly reported that 26 states have developed, or are developing capabilities to use Landsat data. Approximately 40 applications are defined by states as routine and continuous. State investments include $28 million of expenditures (not including personnel resources) since the first satellite was launched in 1972 of which $5 million were expended specifically for the acquisition of software and hardware. The report attributes much of this growth to the low-risk evaluation opportunities provided by the Regional Program.

Unlike the ASVT program area, the Regional Remote Sensing Applications Program has relied to a large extent on demonstration projects normally addressing relatively well proven technology. As a result of these demonstrations, there now exists an extensive and valuable user community (as evidenced by the above NCSL and CSPA report) which has confidence in and experience with Landsat Multi-Spectral Scanner (MSS) technology. The private sector could now take advantage of this receptive environment and continue the application of MSS technology in proven areas. In so doing, the private sector:

- Could maintain and promote proven analytical equipment, techniques, and processes that have a relatively broad appeal to an in-place clientele.
- Could develop their own mechanisms to inform users of well-tried techniques and assist users in initiating their direct application to operational needs through increasing levels of sophistication.
- Could establish complementary relationships with local industries that normally provide states or other clientele with natural resources services, but do not yet have developed Landsat capabilities.
- Could provide training based on established and well-developed methods as part of their marketing program and in response to a broad range of user abilities and user computer environments.
- Could provide day-to-day service contract assistance in the selection and configuration of state systems.
- Could acquire, provide access to, and utilize proven NASA software and hardware developments as a service to users.

To ensure success, the private sector firms will have to address two unique characteristics of the state and local market. First, the state and local community is institutionally difficult and expensive to market. Even at the state level, it is a very diffused market comprised of 50 states and within any one state up to 15 state agencies that may use and benefit from Landsat data. Also, there is a tendency among state governments to contract to firms which are normally based in the state. To date, the remote sensing industry is limited and commercial resources are well established in relatively few states.

Secondly, states generally prefer to internalize continuing functions such as the operational use of remote sensing. States feel that an internal capability is more cost-effective due to the need to use and process Landsat data on a repetitive basis. In addition, states normally already possess much of the hardware and personnel skills needed to develop a remote sensing center. As a result, private companies that address the state market must plan to develop specialized services and products which complement the basic in-house capability of states. In so doing, economies of scale may be realized by private companies providing Landsat derived resource information in a standardized form on a subscription basis to states. The marketing of these techniques on a large scale may be profitable for industry and at the same time cost effective for the states.

In summary, the regional Landsat MSS demonstration projects served to define the user market and develop an initial product line. The completion of this phase of the Regional Program leaves behind a receptive user community and an opportunity for further development of this market by private industry.

3.4 Information Dissemination

3.4.1 Program Description

The Information Dissemination program area distributes the results of NASA's technology activities to ensure that potential users are aware of existing and/or planned technologies; and to facilitate the transfer of technology by the creation of an informed receptive user community. In accomplishing this function, NASA employs existing user communications networks as well as those maintained by the agency. The mechanisms used to accomplish the Information Dissemination objectives include cooperative activities with user representative groups such as the National Governors Association, National Conference of State Legislatures, National Association of Counties, and the National Innovation Network; professional societies and associations such as the American Society of Photogrammetry, American Institute of Planners, and the American Society of Landscape Architects; user oriented documentation including newsletters, user handbooks, procedural manuals, and project reports; and user meetings including major symposia, legislative hearings, discipline workshops and technical conferences.

3.4.2 Feasibility of Transition to Private Sector

Information dissemination activities, much like the User Requirements program area, are an integral part of the development and operation of an earth resources observation satellite system. If the system is transferred to, and operated by a private concern, then Information Dissemination activities, at least those dealing with the operational system, should also be transferred to the private sector. NASA, however, should retain the Information Dissemination activities associated with R&D and emerging new remote sensing techniques such as the Thematic Mapper.

In addition, many of the Information Dissemination activities (i.e., open conferences, workshops, user documentation) have a good potential of relatively near term transfer to the private sector. However, private industry will have to be assured of availability and ease of access to information concerning updated NASA activities to succeed in disseminating relevant information. To ensure the availability of information in a timely manner, NASA would have to maintain identified points of contact for interface with industry.

A potential problem in commercialization of this area is the inherent limited size of these activities. In NASA's Technology Transfer Program, funding for Information Dissemination activities never exceeded approximately $750K. Unless commercialization would drastically expand this base, private sector activities in this area would be limited to a handful of small firms.

An alternative to transferring Information Dissemination to the private sector would be to retain many of the activities in the government, but place them on a cost recovery basis. However, care should be taken that the fees would not tend to limit or reduce exposure to the intended user audience.

3.5 University Applications

3.5.1 Program Description

The University Applications program area provides grants for the development and use of universities to conduct basic and applied research in space applications, and to test and evaluate new remote sensing techniques. Presently, this program maintains 12 geographically-distributed, multi-disciplinary remote sensing centers and 4 centers of discipline expertise in basic and applied research in geology, geodynamics and materials processing. Normally, two additional universities are initiated every year and two are phased out of the program. However, due to budgetary constraints, no new universities have been initiated in this program since FY 1980. Universities are generally phased out after approximately 5 to 6 years when

direct user support makes the university effort self-sustaining. Appendix 3 lists the universities which have participated in the program.

In addition to developing recognized, cross-departmental centers of expertise in space technology and its applications, the University Applications activity serves as the major instrument for encouraging the universities to include remote sensing applications in their curricula, developing basic and specialized courses in space applications, and producing the trained people that are critical to any successful long-term technology transfer program.

3.5.2 Feasibility of Transition to Private Sector

Transfer of the University Applications Program area to the private sector is not a practical consideration. First, it is unlikely that private industry would presently provide grants to universities to conduct research, development, test and evaluation of new remote sensing techniques. This is not to say that it may not occur at some point in the future when the remote sensing market area develops into a substantial business opportunity. At present, however, this activity is perceived as high risk and without any foreseeable immediate payback. Second, it is necessary that NASA continue to develop and use universities as an integral part of its space applications research, test and evaluation activities.

However, when the Civil Operational Land Remote Sensing Satellite System is transferred to the private sector, it would be highly advantageous for the system operator to use a number of the universities which have "graduated" from NASA University Applications programs as sources of regional user assistance. The universities would provide a readily available source of independent expertise in the technology and applications of remote sensing.

4.0 CONCLUSIONS

(1) The private sector presently functions as a vital and necessary team member in each of the NASA Technology Transfer Program areas. Private industries support the operations of the NASA field centers involved in conducting ASVT's and Regional Applications projects, conduct nearly all the Information Dissemination functions, and provide contractural support for the performance of User Requirements studies. On a competitive basis, they are also selected to participate as the technical arm in cooperative projects involving a user organization and NASA. The purpose of these arrangements is to avail industry of new techniques developed by NASA and, in so doing, broaden the industrial base in remote sensing.

(2) Table 1 presents a summary of the analysis of the five Technology Transfer program areas and an overall evaluation of the feasibility of transitioning each area to the private sector. The program area that appears to be most applicable for transition to the private sector is Information Dissemination. Were NASA to make the information available, and assure its continued availability, it seems likely that private sector organizations could perform the function of packaging and distributing the information on a profitable basis. In addition, the Regional Applications Projects which are demonstrations of relatively proven techniques, as opposed to tests of more unproven technology are also candidates for transfer to the private sector. It is not clear, however, whether an adequate remote sensing services industry exists at present to be able to independently service the user community. The areas of Applications Systems Verification and Test, User Requirements and University Applications were determined to have a low feasibility of transfer to the private sector.

(3) To a large extent, the transition of the NASA Technology Transfer Program activities to the private sector are closely linked to the overall transfer of the U.S. Civil Operational Land Remote Sensing Satellite System to a private owner and operator. When this transfer occurs, the private operator will, by necessity, develop linkages with the user community and conduct activities in User Requirements Definition and, Information Dissemination, as well as maintain regional user centers which may encourage technology demonstration projects with users.

(4) Any abrupt discontinuity or reduction in the functions that are now performed by NASA, without an immediate entry of the private sector, will impede or reduce the technology transfer process and may slow the transition to the private sector as a result of increased start-up costs. A sudden reduction or termination may result in serious damage to the users' perception of program credibility at a time when an adequate user base is critical to the transfer of the Civil Operational Land Remote Sensing Satellite System to a private owner and operator. In addition, users will be faced with the integration of a new technology (Landsat-D Thematic Mapper) in the near future. The adaptation of this improved technology with different geometric, radiometric, and spectral characteristics will be a critical bridging process for the user community as well as for the value-added services industry. A more gradual transition, however, will facilitate the transition of these functions in a manner that preserves the integrity of the established remote sensing technology transfer process, and maximizes the utility of NASA R&D.

(5) New remote sensing technology generated by NASA in its R&D endeavors is the resource upon which future technology transfer activities will be built. The private sector will require the assurance of the continuing role of NASA in R&D activities prior to an investment of resources to provide any technology transfer function for the NASA developed technology.

(6) A number of problems which impede increased commercialization of remote sensing relate to the lack of a recognized and permanent mechanism for on-going communications and cooperation between the Federal Government and the remote sensing industry. To the extent that it is appropriate, NASA should encourage the establishment of a broad industry association that is representative of the different industries involved in remote sensing services ranging from small information systems consulting firms to large aerospace companies. This association would serve as a non-profit focal point for educating and expanding the remote sensing market, representing industrial interests to the federal, state and local government, providing consultation on requirements, conducting industry workshops and generally striving for increased involvement of industry in remote sensing.

(7) An active role will be required on the part of NASA to make information concerning new R&D in remote sensing readily available to private industries involved in technology transfer activities. Access to knowledgeable people within NASA will be an important part of this process. To encourage private participation, a focal point for contact by the private sector in connection with remote sensing should be identified within NASA.

(8) As a result of an overall intent to internalize the technology by the Landsat user community, private industry may find it difficult to significantly penetrate the Landsat services market unless care is taken to provide low cost, specialized services which complement the users' own capabilities. Landsat users commonly choose to acquire and utilize the hardware and software necessary to conduct remote sensing analysis internal to their organization for the following reasons:

- Internal capability can be drawn on as required and on a repetitive and ad hoc basis as compared to the necessity of contracting out with every requirement; the flexibility provided by an internal capability is perceived as more cost-effective.

- Remote sensing and data processing services are traditionally conducted in-house, in state governments, many Federal agencies, as well as major private industry users such as many mineral and petroleum companies.

- o Most potential users possess adequate critical mass and core capabilities in terms of personnel and equipments which are necessary to develop a Landsat data processing capability.

- o Contracting with external sources on a "job" basis is perceived as not compatible with continuous and iterative nature of Landsat use.

- o Landsat data are often used in company sensitive or state and Federal regulatory functions.

- o Landsat use is an integral part of a users overall geobased information system which is normally internally based and operated.

These factors will need to be evaluated in terms of business plans and product lines as industries enter the remote sensing services area.

(9) The impacts of the transition of the technology transfer functions to the private sector may be significant. An objective of the NASA Technology Transfer Program is to maximize the public benefits from NASA R&D by exposing the technology to a variety of users. On the other hand, an objective of a private sector organization engaged in the technology transfer process will be to maximize its benefits (profits) primarily by directing its efforts toward the large amalgamated markets. To the extent that the public and private benefits overlap, the focus of the technology transfer process will be unchanged; however, it should be realized that these differing objectives could lead to significantly different programs and impacts on the user community. One possible impact may be that more speculative applications areas may not be undertaken, though it might be in the public interest to pursue them. If this occurs, it may be desirable, for the Federal government to provide direct support to technology transfer efforts by private industry which are directed toward less financially attractive opportunities but represent important social or diffused economic benefits.

(10) The rationale and assumptions behind NASA's involvement in cooperative activities with the user community are still solid and to the overall benefit of the Nation. First, as an R&D agency, NASA must continue to involve itself in the test and evaluation of new technology to determine its viability in a variety of test settings, and to obtain user feedback for future program planning. Second, NASA has a basic obligation to actively disseminate information from its remote sensing technology activities particularly to user sectors which are not being addressed by the remote sensing service industry; third, the advantages of NASA field centers as an open forum for exploration of new technology without the immediate constraints

Table 1

ANALYSIS OF TECHNOLOGY TRANSFER PROGRAM AREAS
FOR TRANSITION TO THE PRIVATE SECTOR

PROGRAM AREA	MECHANISMS	FEASIBILITY OF TRANSITION TO PRIVATE SECTOR	COMMENTS/RATIONALE
o User Requirements Definition	- Cooperative activities with User Representative Groups, professional associations, institutes and societies	- Low (Technology & technique related)	- Integral part of developing and operating earth resources observation satellites
	- Discipline studies with user working groups, panels through NASA field centers	- Medium (Operations related; dependent on existence of private owner/ operator)	- Transfer to private sector strongly dependent on transition of of entire U.S. Civil Operational Land Remote Sensing Satellite System to private owner/operator
			- Private owner/operator should conduct User Requirements studies related to system operations
			- NASA should retain those User Requirements activities necessary for conduct of remote sensing R&D, test and evaluation
			- Private industry user consortia and associations should be encouraged to conduct requirements analysis in applications area of specific interest to them

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Table 1 (Cont'd)
ANALYSIS OF TECHNOLOGY TRANSFER PROGRAM AREAS
FOR TRANSITION TO THE PRIVATE SECTOR

PROGRAM AREA	MECHANISMS	FEASIBILITY OF TRANSITION TO PRIVATE SECTOR	COMMENTS/RATIONALE
o Applications Systems Verification and Test	- Cooperative Test and evaluation projects with users	- Low	- Unlikely that private industry would perform high-risk test and evaluation of emerging technology - Both the user community and remote sensing industry is not yet technically mature, and not very certain/ confident concerning the future of space remote sensing - Essential for NASA as test bed of new remote sensing techniques in representative user setting and as source of user feedback for future program planning
o Regional Remote Sensing Applications	- Regional Applications projects	- Medium	- Demonstrations consist of lower risk projects with more proven techniques - Completion of Regional Applications Projects leaves behind receptive user community for commercialization by private sector

Table 1 (Cont'd)

ANALYSIS OF TECHNOLOGY TRANSFER PROGRAM AREAS
FOR TRANSITION TO THE PRIVATE SECTOR

PROGRAM AREA	MECHANISMS	FEASIBILITY OF TRANSITION TO PRIVATE SECTOR	COMMENTS/RATIONALE
			- Some questions still exist as to sufficiency of user market for private industry; historically state and local market has not been addressed by remote sensing industry due to marginal profitability, low volume, geographically diffused/difficult to market, and internal orientation
o Information Dissemination	- Two-way communications program with User Representative groups, professional associations, institutes and societies	- High	- In general, low-risk activity which existing private industry is fully capable of performing
	- User documentation (handbooks, newsletters, procedural manuals and project reports)		- Some commercialization has already taken place
	- User meetings, (symposia, workshops, and technical conferences)		- Unless commercialization expands user base substantially, the limited size of area may decrease attractiveness to industry

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Table 1 (Cont'd)

ANALYSIS OF TECHNOLOGY TRANSFER PROGRAM AREAS
FOR TRANSITION TO THE PRIVATE SECTOR

PROGRAM AREA	MECHANISMS	FEASIBILITY OF TRANSITION TO PRIVATE SECTOR	COMMENTS/RATIONALE
			- Cost-recovery approach is also feasible
o University Applications	- NASA grants for basic and applied research; test and evaluation of emerging techniques	- Low	- Unlikely private industry would provide grants to universities in space applications at this point in market development - Necessary that NASA continue to develop and use universities as integral part of its remote sensing research, test and evaluation activities

of proprietary information, company confidentiality and profit motives are important and need to be continued; and fourth, it is clear that space remote sensing is still in an early phase of development, although the potential benefits are large, the user community as well as the private remote sensing industry is still small and perceives a high risk which will probably impede significant investment in the near future.

APPLICATIONS SYSTEMS VERIFICATION & TEST (ASVT) PROGRAM

PROJECT	TEST & EVALUATION OBJECTIVE	PARTICIPATING USERS
Pacific Northwest Land Inventory	- Evaluate Landsat as multipurpose land resources inventory system with emphasis on detection and inventory of noxious weeds, irrigated agriculture, and forestlands	- U.S. Geological Survey - Pacific Northwest Regional Commission - WA, ID, OR
Snowcover Mapping	- Evaluate use of Landsat data for measuring snow-cover area as input to snowmelt runoff prediction	- Corps of Engineers - National Oceanic & Atmospheric Administration - U.S. Geological Survey - U.S. Bureau of Reclamation
Water Resources Management	- Evaluate suitability of Landsat data in Corps of Engineers hydrologic engineering models for flood frequency prediction in watershed	- Corps of Engineers
Texas Natural Inventory and Monitoring System	- Evaluate integration of remote sensing data into state resource information system for coastal zone management, playa lake inventory, and wildlife habitat mapping	- 16 Texas state agencies
Appalachian Lineaments Analysis	- Evaluate use of enhanced Landsat imagery in geologic lineament analysis for delineation of Appalachian Devonian gas shale areas	- Appalachian Regional Commission - Geological surveys of NY, PA, OH, VA, WV, KY, TN
Water Detection & Mapping	- Evaluate use of Landsat data in mapping of water impoundments as required by U.S. Dam Safety Act being administered by Corps of Engineers	- Corps of Engineers
National Park Management	- Evaluate multi-source data integration and analysis technique for fire hazard assessment modeling	- National Park Service

APPLICATIONS SYSTEMS VERIFICATION & TEST (ASVT) PROGRAM (CONT'D)

PROJECT	TEST & EVALUATION OBJECTIVE	PARTICIPATING USERS
Alaska State, Federal and Local Landsat Evaluation	- Evaluate Landsat data for land suitability analysis	- Alaska State & Local Agencies - U. of Alaska - Environmental Systems Research, Inc. - Tanana Chiefs Conference - U.S. Geological Survey - U.S. Forest Survey - Bureau of Land Management - Soil Conservation Survey
California Integrated Resource System	- Evaluate integration of Landsat data into geobased information system for forest inventory, and reforestation and air quality modeling	- U. of Calif., State Agencies Legislature - USGS, USDA Forest Service Public Utility, Private Sector
Florida Water Management Districts	- Evaluate Landsat data and microprocessor analysis system for watershed management by substate regional water management districts	- U. of Florida, State Water Districts
Power Utility Planning	- Evaluate Landsat data in power consumption and distribution modeling	- Pacific Gas & Electric; - Electric Power Research Institute

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

State	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Alabama			Metrics, Inc., AL Development Office		Low cost system development; software support
Alaska	- General land cover	- Dept. of Natural Resources	Local govt's	21	User needs survey
	- Land and water use	- Dept. of Natural Resources	Local govt's		
	- Road/construction site identification,	- Dept. of Natural Resources	Local govt's		
	- Intertidal zone measurement, coastal processes	- Dept. of Fish/Game			
	- Habitat classification	- Dept. of Fish/Game			
	- Forest inventory	- Dept. of Natural Resources	Local govt's		
Arizona	-Land cover classification	- Dept. of Game & Fish, Dept. State Land/Info. Resources Div.	U.S. Forest Service, U.S. Geological Survey		
	- Wildlife habitat change				
	- Irrigated land delineation	- Dept. of Water Resources			
Arkansas	- Land cover baseline	- Geological Commission	Arkansas Technical U., U. Arkansas		
	- Forest species identification	- Forestry Commission, Geol. Comm.			
	- Surface water inventory	- Soil/Water Conservation Comm., Dept. of Pollution Control/Ecology			
	- Land use change	- Ozark Regional Comm., Dept. of Economic Devel., Highway/Trans. Dept.			
	- Data base construction	- Dept. of Computer Services			
California	- Forest inventory	- Dept. of Forestry, Environmental Data Center		221	User needs assessment, software
	- Prime agricultural land use change	- Dept. of Food/Agriculture, Soil Conservation Service	Fresno County, Ventura County	support	
	- Water resources inventory	- Water Resources Control Board			
	- Watershed condition inventory	- U.S. Fish/Wildlife Service	Humboldt State U.		
	- Irrigated lands assessment**	- Dept. of Water Resources	U. Cal. Berkeley, Santa Barbara		
	- Vertical integration of Landsat Data* (Forestry, Prime Agric. Land, Urban Growth, Reg. Land Cover)	- Environmental Data Center, Depts of Water Resources, Bay Area Council of Gov't., San Bernadino County, Forestry, Food & Ag., CA Dept. of Forestry	U. Cal Berkeley, Santa Barbara, Humboldt State U., USGS, USFS, industry		

* Applications System Verification and Transfer (ASVT) project
** Applications Pilot Test

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

State	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Colorado	- Land use	- Pueblo Area Council of Govt's, Div. of Planning		45	
	- Loss of prime ag. land	- Dept. of Agriculture, Div. of Planning			
	- Wildlife habitat delineation	- Dept. of Natural Resources/Wildlife Div., Div., of Planning			
	- Forest inventory/ infestation	- State Forest Service, Div. of Planning			
	- Irrigated land inventory	- Dept. of Agriculture, Colorado Mapping Advisory Committee	Colorado State U.		
Delaware	- Land cover change	- Dept. of Natural Resources & Envrionmental Control	U. Delaware; Heritage Conserv. and Recreation Service	6	Analysis Support to Univ.
	- Wetland inventory/change detection	- Dept. of Natural Resources & Environmental Control			
	- Data base integration	- County Water Res. Agency			
	- Loss of prime agricultural land	- Dept. of Natural Resources and Environmental Control			
Florida	- Land cover classification	- Water Management Districts, Dept. of Transportation	U. Florida	22	System Specification, Software Support, University short courses
	- Forest species identification	- Dept. of Natural Resources			
	- Coastal zone assessment/ wetlands Delineation	- Dept. of Environmental Regulation, Coastal Zone Office N.W. Water Management District			
	- Surface water inventory	- Water Management Districts			
	- Data base construction	- Dept. of Planning			
	- Agricultural land use	- Dept. of Economic Development			
	- Water resource management*	- 6 Florida Water Res. Mgt. Districts			
Georgia*	- Coastal zone vegetation mapping	- Dept. of Natural Resources	Georgia Tech, Univ. Georgia	18	Univ. short course support, system specification, software support
	- Land cover	- Dept. of Natural Resources			
	- Land use change detection	- Dept. of Natural Resources			
	- Water quality district land use	- Dept. of Natural Resources			

* Applications Systems Verification and Transfer (ASVT) project

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REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

State	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Hawaii	- Land use	- County of Hawaii (Plan Dept.)		7	User needs assessment, software support
	- Coastal zone management	- Dept.Planning/Economic Dev., Office of Env.Quality Control			
	- Forest inventory	- Dept.of Land/Natural Resources, Dept. of Agriculture			
	- Agricultural land inventory	- Dept. of Land/Natural Resources			
Idaho*	- County land use	- County Planning Commissions and Councils	U. of Idaho	56	User needs assessment, software
	- Vegetative resources	- Dept. of Fish/Game, Dept. of Lands			
	- Irrigated land inventory	- Dept. of Water Resources			
	- Dam failure damage assess.	- Dept. of Agriculture			
	- Forest inventory	- Dept. of Lands			
	- Forest & wetlands inventory	- Dept. of Natural Resources, Dept. of Forestry		2	
Illnois	- Land cover/forest cover inventory	- Dept. of Natural Resources/ Div. of Forestry		2	
owa	- Flood impact evaluation	- Iowa Geological Survey	Iowa State U.	12	System specification, mgt. analysis
	- Erosion hazard potential	- Land Use Laboratory, Soil Conservation Service			
	- Agricultural land use change	- Tax Bureau, Dept. of Agriculture			
	- Urban growth	- Dept. of Admin.Div.Planning			
Kansas	- Land use/value assessment	- Dept.of Agricultural, Water Resources Board, Dept.of Revenue	U. Kansas		University short courses
	- Irrigated land inventory	- Dept. of Agriculture, Water Resources Board			
	- Erosion hazard potential	- Dept. of Health & Environment, Conservation Commission			
	- Land use value assessment	- Dept. of Revenue			
Kentucky			Murray State U.	22	System & software specification and referral to private sector, university short courses

* Applications Systems Verification and Transfer (ASVT) project

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

te	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
isiana	- Changes due to coastal erosion - Loss of prime agric. land - Runoff impact on water quality	- Lafourche Parish (county)	Louisiana State U.	18	Training capability development System & software support, mgt. analysis, univeralty short courses
ine	- Land cover, forest condition	- Dept. of Conservation, Dept. of Environmental Protection, Dept. of Inland Fisheries/Wildlife, State Planning, Dept. of Agric.	Univ. of Maine		
	- Land use change	- Dept. of Conservation			
ryland	- Integrate landsat data w/Geographic Info. System	- Dept. of State Planning	U. Maryland, Earthsat Corp.	15	Software Support
	- Holding pond inventory	- Dept. of Natural Resources			
	- Forest inventory	- Dept. of Natural Resources			
	- Land cover classification	- Dept. of State Planning			
	- Sand/gravel pit inventory	- Dept. of Natural Resources			
chigan	- Wildlife habitat inventory	- Dept. of Natural Resources	Environmental Research Institute of Michigan, Michigan Energy & Resource Research Assoc.	8	
	- Transportation planning	- Dept. of Highways & Trans.			
	- Forest inventory/change detection	- Dept. of Natural Resources			
innesota	- Lake water quality	- Pollution Control Agency, Dept. of Natural Resources		11	System specification support
	- Irrigated land inventory	- Dept. of Natural Resources, Dept. of Agriculture*			
	- Urban fringe land cover change	- State Planning Agency			
ississippi*	- Agriculture survey/crop production	- Ag. Extension Service	Mississippi State U.	13	System software & hardware support, univ. short courses
	- Soil Conservation/re-forestation	- Ag. Extension Service			
	- Wildlife habitat assess.	- Game and Fish Commission			
	- Coastal vegetation/ salinity mapping	- Marine Resources Council (Project oversight, MS R&D Center)			

*Applications Systems Verification and Transfer (ASVT) project

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

FEB 4 1982

Honorable Don Fuqua
Chairman
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Enclosed is a waiver of the requirements of section 11(b) of the Stevenson-Wydler Technology Innovation Act of 1980, P.L. 96-480, which includes a statement of the reasons for the waiver and NASA's alternate plans for conducting technology innovation functions.

Sincerely,

James M. Beggs
Administrator

Enclosure

cc:
Honorable Larry Winn, Jr.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Waiver of Requirements Set Forth in Section 11(b) of the Stevenson-Wydler Technology Innovation Act of 1980, P.L. 96-480

Pursuant to authority vested in me by subsection (b) of section 11 of P.L. 96-480, 15 U.S.C. 3710(b), I hereby waive the requirements set forth in clauses (1) and (2) of that subsection.

Section 11(b) of P.L. 96-480 provides that each laboratory having a total annual budget exceeding $20 million must provide at least one professional individual full-time as staff for its Office of Research and Technology Applications. That section further provides that after September 30, 1981, each Federal agency operating one or more Federal laboratories must make available not less than 0.5 percent of the agency's R&D budget to support the technology transfer function at the agency and at its laboratories.

Section 11(b) allows an agency head to waive the requirements set forth above and, if he waives such requirements, he must submit to Congress at the time the President submits the Budget to Congress an explanation of the reasons for the waiver and alternate plans for conducting the technology transfer function at the agency.

The basis for this waiver of the requirements of section 11(b) for NASA is the fact that NASA has in place an alternate program to achieve the objectives of the Act. The agency operates programs at NASA Field Centers which provide technical assistance and disseminate information and technology to state and local governments and the private sector. For example, each NASA Field Center has Technology Utilization Officers and staff, and three Field Centers have additional Regional Remote Sensing Demonstration Centers. The effectiveness of the NASA technology innovation and dissemination programs is widely recognized and appreciated by technology recipients (state, local and Federal government, and the private sector) as well as by the Congress. Without this waiver, NASA's response to the specific requirements of the Act could result in duplication and unnecessary confusion of Field Center roles in technology innovation and could thus disrupt existing programs.

James M. Beggs
Administrator

FEB 4 1982
Date

93-418 O - 82 -- 107

National Aeronautics and
Space Administration

Washington, D.C.
20546

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MAR 10 1982

COMMITTEE ON SCIENCE
AND TECHNOLOGY

Honorable Don Fuqua
Chairman, Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Public Law 96-304, dated July 8, 1980, relating to HUD and Independent Agencies' Supplemental Appropriations for Fiscal Year 1980 (Section 307), required the Inspectors General to submit to the Congress, along with agencies' annual budget justifications, an evaluation of agencies' progress to institute effective management controls over consultant service contracts. The evaluation also is to cover agencies' efforts to improve the accuracy and completeness of the data provided to the Federal Procurement Data System for these contracts. This memorandum contains our evaluation of the progress which NASA has made in these efforts.

Since our evaluation report to Congress in January 1981, NASA has issued NASA Management Instruction 5104.5 (February 12, 1981) "Policy and Guidance for the Use of Consulting Services Obtained by Contract." We believe that the NASA policy effectively establishes the controls which are required by the Office of Management and Budget. NASA also has incorporated its policy into the NASA Procurement Regulation via Procurement Regulation Directive 81-2, dated April 22, 1981.

During FY 1981, we performed a test review of the NASA management control system by reviewing its implementation at NASA Headquarters and at Marshall Space Flight Center. NASA has made good progress in implementing the management control system at those locations. We also determined that the data provided to the Federal Procurement Data Center on NASA contracts for those installations was accurate and complete.

As required by PL 96-304, we will continue to evaluate NASA progress in controlling consulting service contracts. We will test the controls at other NASA installations and submit our evaluation to Congress along with the FY 1984 budget justification.

J. Brian Hyland, Jr.

June Gibbs Brown
Inspector General

cc:
Honorable Larry Winn, Jr.

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

JUN 14 1982

Honorable Ronnie G. Flippo
Chairman
Subcommittee on Space
Science and Applications
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

In House Report 97-32, accompanying H.R. 1257, authorizing appropriations to NASA for FY 1982, the Committee cited its belief that significant economies could be achieved through a block buy of additional Shuttle orbiters, and requested NASA and the Air Force to review the requirements for additional orbiter vehicles. The Conference Report (House Report 97-351) further directed that within available funds, NASA should procure long-lead materials necessary to maintain the most efficient production schedule for a fifth Space Shuttle orbiter. In House Report 97-502 accompanying H.R. 5890, the NASA Authorization Act for FY 1983, the Committee has also directed that NASA "provide appropriate funding for long-lead materials to maintain an option for procurement of additional orbiters."

The purpose of this letter is to bring you up-to-date on the status of certain Agency actions relative to a potential "block buy" of additional orbiters, with particular emphasis on potential acquisition of a fifth orbiter, OV-105.

NASA recently held top level meetings with the prime Space Transportation System contractor, Rockwell International, and three major subcontractors, General Dynamics, TRW and McDonnell Douglas. These meetings were held to set forth NASA's position regarding procurement of additional orbiters; to determine where the subcontractors stood in closing out their current orbiter activities; and finally, to assess their receptiveness to our proposed contracting methods.

Subsequent to these reviews preliminary actions were initiated which will provide data for the evaluation of a potential OV-105 procurement. Specifically, NASA's Johnson Space Center has been directed to request from Rockwell a proposal preparation effort with two major options:

Option I: Procurement of OV-105 and a final block buy of key subsystem spares; and,

Option II: Same as Option I with the addition of a sixth orbiter, OV-106.

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

tate	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Missouri	- Public land acquisition for conservation	- Dept. of Conservation	U. Missouri	32	System and software support
Montana	- Irrigated agriculture inventory	- Dept. of Revenue, Dept. of Natural Resources/Conservation, Dept.of Community Affairs		4	
	- Forest inventory	- Dept. of Revenue,Dept.of Natural Resources/Conservation, Dept.of Community Affairs			
	- County land use	- Cascade Co. Planning Board Dept. of Community Affairs	Montana State U. Committee on Rural Dev., U.S. Fish/Wildlife Service		
	- Dam/reservoir inventory	- Dept. of Natural Resources/Conservation,Dept.of Community Affairs	Montana State U.		
	- River basin management (forest, water, urban, agric.)	- Flathead River Basin Study Group (nine agencies)			
Nebraska	- Irrigated land inventory - Wildlife habitat evaluation	- Natural Resources Comm. - Game and Parks Comm.	U. Nebraska		
Nevada	- Forest inventory - Forest fire hazard potential	- Dept. of Natural Resources & Conservation, Div. of State Lands, Div., of Forestry	U. Nevada		Software Support
	- Wildlife habitats	- Dept. of Natural Resources & Conservation, Div.of State Lands, Div. of Forestry			
New Jersey	- Forest inventory	- Dept. of Environmental Protection/ Div. of Forestry		20	Software support
	- Land cover in environmentally sensitive areas	- Dept. of Environmental Protection/ Bureau of Green Acres			
	- Coastal zone development	- Dept. of Env. Protection/Office of Coastal Zone Mgt.			
New Mexico	- Forest species identification/timber management	- Dept. of Natural Resources, Forest Service, Fish/Game Div.	U. New Mexico	13	System specification, analysis & software support
	- Land cover classification	- Forest Service, Fish/Game Div. State Engineers Office			
	- Grasslands identification range management	- Dept. of Natural Resources			
	- Deer habitat identification	- Dept. of Natural Resources, Fish/Game Div.			

1985

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

:ate	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
ew York	- Wildlife habitat assess. - Forest inventory - Forest clearcut monitoring	- Dept. of Environmental Cons. - Dept of Environmental Cons. - Adirondack Park Agency	State U. of NY (Albany, Oneonta)	6	System & Software Support to Univ.
orth Dakota			North Dakota Legislative Council	37	Validation of land cover analysis
hio	- Strip mine monitoring - Land cover inventory/ change - Wildlife habitat	- Dept. of Natural Resources - Ohio Environmental Protection Agency - Dept. of Natural Resources	Ohio State U.	4	Software Support
klahoma			Oklahoma State U.	35	System and software support, to establish operational system, univ. short course support
regon*	- Land cover inventory - Forest condition - Irrigated land inventory - Noxious weed inventory - Rangeland resources mapping & inventory - Reservoir volume determination - Surface mine detection	- County & Local Govt., Dept. of Transportation Dept. of Env. Quality - Dept. of Forestry - Dept. of Water Resources - Dept. of Agriculture - Dept. of Fish/Wildlife - Dept. of Water Resources - Dept. of Geology & Mineral	Oregon State U.	50	User needs assessment
outh Carolina	- Forestry inventory - Land cover classification/ environmental baseline - Surface water inventory - Eagle habitats - Marsh delineation - Land use/resource mgt. planning	- Land Resources Commission - Coastal Zone Mgt. Dept., Wildlife/Marine Resources Dept. - Land Resources Commission - Wildlife/Marine Resources Dept. - Coastal Zone Mgt. Dept. - Land Resources Commission	U. South Carolina	6	System specification sotware system analysis

* Applications Systems Verification and Transfer (ASVT) project

1986

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

State	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Tennessee	- County land cover	- Rutherford Co. Reg. Planning Comm., State Planning	Middle Tenn. State U. Memphis State U.	9	Low cost system analysis/specification
	- Surface mine inventory	- Div. of Surface Mining, State Plng.			
	- Wildlife habitats	- Wildlife Resources Agency			
	- Hardwood forest delineation	- Div. of Forestry			
	- Recreation area delineation	- Dept. of Conserv.			
Texas*	- Coastal zone management	- Coastal & Marine Council, General Land Offices		9	Software/system Development support
	- Forestry management	- Texas Forest Service			
	- Water resources	- Dept. of Water Resources			
	- Agriculture	- Dept. of Agriculture			
	- Land cover	- General Land Office (all projects coordinated through Texas Natural Resources Info. System)			
Utah	- Vegetation/Wildlife habitat mapping	- Dept. of Natural Resources, Div. of Wildlife Resources	U. Utah	3	
	- Forest inventory	- DNR, Div. of State Lands & Forestry			
	- Mineral development impact	- DNR, Div. of Oil/Gas/Mining; Geological & Mineral Survey; State Planning Office			
	- Water resources				
Vermont	- Forest tent caterpillar infestation	- Agency of Environ. Cons: Dept. Dept. of Forests, Parks & Recreation	U. Vermont	17	
	- Forest inventory	- Dept. of Forests/Parks/Recreation			
	- Watershed & lake inventory	- Dept. of Water Resources			
	- Land use change detection	- Office of State Planning			
	- Lake water clarity	- Dept. of Water Resources			
Virginia	- Forest inventory	- Dept. of Cons./Div. Forestry	Old Dominion U. Virginia Polytech Institute	16	Software Support to Univ.
	- County land cover	- Regional Planning Commission, Dept. Conservation			
	- Surface mine reclamation	- Dept. Cons./Div. Mined Land Reclamation			
	- Watershed land cover, runoff & water quality	- Water Control Board, Chesterfield County	College of William and Mary		
	- Geobased info. system integration	- VA Resources Info. Task Force			
	- Vegetation assessment for air quality modeling	- Air Pollution Control Board			

* Applications Systems Verification and Transfer (ASVT) project

REGIONAL REMOTE SENSING APPLICATIONS PROGRAM
STATE PROGRAM STATUS

State	Landsat Applications	State Agency	Other Participants	State Personnel Trained	Other Support
Virginia	- Regional land use	- Piedmont Planning District Commission	College of William and Mary		
Washington*	- Urban land inventory	- Planning & Community Affairs Agency, local & regional govt's	U. Washington	64	User needs assessment, software
	- Land cover inventory	- Dept. of Game, County Planning			
	- Game habitat inventory	- Dept. of Game			
	- Rangeland resources mapping & inventory	- Dept. of Game			
	- Forestry inventory	- Dept. of Natural Resources			
West Virginia			Marshall Univ.	13	
Wisconsin	- Lake Eutrophication	- Dept. of Natural Resources	U. Wisconsin		
Wyoming	- County land use	- State Planning Coord.			

* Applications Systems Verification and Transfer (ASVT) project

UNIVERSITY APPLICATIONS

UNIVERSITIES	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983
OLD DOMINION *						
MICHIGAN/ERIM *						
VIMS *						
LOUISIANA STATE *						
PURDUE *						
CALIFORNIA STATE						
TEXAS A&M						
WISCONSIN						
ALASKA						
COLORADO						
SOUTH DAKOTA STATE						
CORNELL						
MINNESOTA						
CALIFORNIA-BERKELEY						
SOUTH CAROLINA						
KANSAS						
OREGON STATE						
MICHIGAN STATE						
NEBRASKA						
ARIZONA						
MISSISSIPPI						
UTAH						
FLORIDA						
ARIZONA (SPACE PROCESSING)						
M.I.T. (SPACE PROCESSING)						
VERMONT						
OKLAHOMA STATE						
CALTECH (GEODYNAMICS)						
MARYLAND						
MISSOURI						
U. WASHINGTON (GEOLOGY)						

* SUPPORTED BEFORE FY 1978

Rockwell has been directed to submit its initial response to the Government this month. The response will provide preliminary cost data, including target costs and not-to-exceed estimates. Concurrently, NASA is also conducting its own review to be in a position to independently assess the contractor's projected data. In addition, Rockwell has committed to submitting a firm cost proposal in October 1982. This submittal could result in a negotiated contract in 1983 and a vehicle delivery in mid-1987. However, no further effort beyond the above submittals will be undertaken by NASA until Administration and Congressional approval to proceed is given. The type and method of contracting have not yet been decided upon, although the Agency's goal would be to obtain a substantial commitment from the contractor in the form of a heavily incentivized contract.

One final and immediate step NASA has taken is to protect our ability to procure future additional hardware in the most economical fashion. Some of the second and third tier vendors, particularly avionics suppliers, will be shortly closing down their lines as the last of their OV-104 hardware is delivered. Therefore, I have authorized the long-lead procurement of certain items which are determined to be necessary spares required for the presently approved four orbiter fleet.

We will continue to keep you informed as further information is available, and the Agency's plans are definitized.

Sincerely,

James M. Beggs
Administrator

cc:
Honorable Harold C. Hollenbeck

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

JUN 12 1981

Honorable Ronnie G. Flippo
Chairman
Subcommittee on Space
Science and Applications
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Thank you for your May 27, 1981, letter and the Committee's continuing interest in NASA's Technology Utilization program. As you are aware, the Congress recently restored $2 million in FY 1981 funds to the Technology Utilization program in the Supplemental Appropriations and Rescission Act, 1981 (P.L. 97-12). Given this restoration, NASA does not plan additional allocation of funds for Technology Utilization for FY 1981.

We plan to utilize the $2 million restoration as follows: $100 thousand to support the research, writing and publication of Spinoff 1982; $400 thousand to proceed with six bioengineering projects, including four to assist the handicapped; $400 thousand for projects relating to environmental control; $400 thousand for near-term support of deep-sea technology efforts (which will eventually be transferred to other agencies for long-term support); $75 thousand for extension of support of the Industrial Applications Center concept; approximately $400 thousand to support new technology reporting, technology screening and user inquiry response; and $200 thousand for studies and evaluation of the Technology Transfer program.

With respect to NASA's plans for publications such as Spinoff and Tech Briefs, the current status is as follows:

- Spinoff 1981 is being printed and should be distributed within a week;
- Spinoff 1982 contractual arrangements for research and writing activities are in process; and,
- Tech Brief Journal contractual arrangements for FY 1981 accommodate printing of the planned four volumes; one volume has already been released. Planned distribution for each volume is 75,000 copies, in accordance with the current Office of Management and Budget ceiling.

Future plans for these publications are currently under review as part of NASA's response to OMB Circular 81-16 concerning the President's moratorium on government publications. These documents will also be included in NASA's review of activities and institutional arrangements in the Technology Utilization program, which was requested in the Committee's Report accompanying the NASA FY 1982 authorization bill. NASA plans to examine the feasibility of making the Tech Brief Journal a paid subscription document.

Thank you again for your support of NASA's Technology Utilization program. If we can provide further information in this regard, please do not hesitate to let me know.

Sincerely,

for A. M. Lovelace
Acting Administrator

TECHNOLOGY UTILIZATION
FY 1981 BUDGET REVISIONS AND STATUS

TECHNOLOGY DISSEMINATION

$5M REDUCTION IMPACT - $ 1410K

Publications:
- Eliminate special publications, including Spinoff annual report; and reduce Technical Support Package(TSP) preparation by 60% (-$585K)

Dissemination Centers:
- Renegotiate all dissemination center contracts (average reduction of 25%); convert to incremental funding of contracts to maintain integrity of dissemination center network operations (-$825K)

$2M RESTORATION PLAN + $ 225K

Publications:
- Publication of Spinoff annual report ($100K)
- Add funds to reduce backlog of "New Technology Report" technical screening ($50K)

Dissemination Centers:
- Restore funds for Kerr Industrial Applications Center ($75K)

NET IMPACT ($3M T.U. REDUCTION) - $1185K

Publications:
- No special publications will be supported and the ability to support Field Center efforts for preparing Technical Support Packages is eliminated. Backlog of New Technology Report screening and evaluation at SRI will only be partially addressed.

Dissemination Centers:
- The Industrial Applications Centers are all operating on a reduced annual budget.

TECHNOLOGY UTILIZATION
FY 1981 BUDGET REVISIONS AND STATUS

PROGRAM EVALUATION AND SUPPORT

$5M REDUCTION IMPACT — - $ 1148K

Evaluation:
- Eliminate all program evaluation, benefits analysis, and economic impact analysis activities, including user follow-up and Space Benefits (-$487K)

Support:
- Reduce ability to respond to technical inquiries generated by NASA Tech Briefs; terminate applications support (-$661K)

$2M RESTORATION PLAN — + $ 575K

Evaluation:
- Renew contract for user follow-up and benefit assessment (Denver Research Institute) at a reduced level ($200K)
- Augment field center overhead for new technology reporting and user inquiry response ($50K)

Support:
- Restore support for preparation of Technical Support Packages and user inquiry response ($325K)

NET IMPACT ($3M T.U. REDUCTION) — - $ 573K

Evaluation:
- Since only a portion of the evaluation contract with Denver Research Institute will be renewed, only a portion of the support studies and evaluation efforts (such as pricing analysis for Tech Briefs and subscription and private sector transition review) will be conducted.

Support:
- Reduced effort in user follow-up.
- Reduced level of responsiveness to user inquiries and reduced Technical Support Package preparation support at STI Facility.

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TECHNOLOGY UTILIZATION
FY 1981 BUDGET REVISION AND STATUS

CIVIL SYSTEMS

$5M REDUCTION IMPACT - $ 1300K

- Terminate 4 environmental projects (-$430K)
- Slow down 4 undersea projects(-$870K)

$2M RESTORATION PLAN $ -0-

- No FY 1981 restoration.

NET IMPACT ($3M T.U. REDUCTION) - $ 1300K

Civil Systems will be phased out, and certain elements and projects will be incorporated in the Technology Applications Projects element of Technology Utilization.

TECHNOLOGY UTILIZATION
FY 1981 BUDGET REVISION AND STATUS

TECHNOLOGY APPLICATIONS

$5M REDUCTION IMPACT — - $ 1142K

- Phase out of 5 Applications Teams. (-$335K)
- Terminate 16 applications engineering including 5 bioengineering projects. (-$575K)
- Postpone 3 bioengineering project new starts (-$232K)

$2M RESTORATION PLAN — + $ 1200K

- Restore funds for orderly completion of 3 environmental projects ($400K)
- Restore sea technology program funds to allow transition to other agency support ($400K)
- Restore funds for 6 bioengineering/rehabilitation project starts ($400K)

NET IMPACT ($3M T.U. REDUCTION) — + $ 58K

Bioengineering new starts may include such projects as mobility aids for blind, speech synthesizer for handicapped, advanced wheelchairs or cooling garments for handicapped. Five Applications Teams will be eliminated and sea technology program (formerly in Civil Systems) will be phased over to other agency support or terminated.

1700

ADDITIONAL STATEMENTS SUBMITTED FOR THE RECORD

HARVARD COLLEGE OBSERVATORY

CAMBRIDGE, MASSACHUSETTS 02138

February 22, 1982

The Honorable Ronnie G. Flippo
Chairman, Subcommittee on
Space Science and Applications
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Flippo:

Thank you for your letter of February 5 inviting me, as Chairman of the Space Science Board, to submit a statement for the record of your Subcommittee. I will be pleased to do this; such a statement has been in preparation for some time. Professor E. N. Levy, Chairman of our Committee on Planetary and Lunar Exploration, will be participating in your hearings on the planetary program. Between us, our statements will address the issues raised by FY83 budget submission, and will replace all previous communications. Attached to Professor Levy's statement will be an Academy-approved statement on the value of the planetary program. Attached to my statement will be a narrative summary of the science strategies developed by the Board and its Committees during the last few years.

Despite the fact that the FY83 NASA budget, as submitted, has an overall increase, certain deficiencies create severe problems for the space science community, especially in the universities. These deficiencies are addressed in detail in my statement. I hope that the Congress will be able to alleviate most of these difficulties.

Yours sincerely,

A. G. W. Cameron

A. G. W. Cameron
Chairman, Space Science Board

STATEMENT ON THE NASA FY 1983 AUTHORIZATION REQUEST

A.G.W. Cameron
Chairman, Space Science Board

OVERVIEW

In past years I have had several occasions to testify on the NASA budget; the concern of the Space Science Board that I frequently expressed was that the lack of new starts is seriously compromising our capability for carrying out a national space program that addresses the most pressing scientific issues. Clearly we have now entered an even more difficult time. Not only are there no new initiatives, but we are facing the circumstance that each new budget raises the question of which already approved program will be canceled.

During the last year we have seen the effective cancellation of two missions, the U.S. spacecraft that was to be part of the International Solar Polar Mission (ISPM) and the Venus Orbiting Imaging Radar (VOIR) mission. The cancellation of those missions was not a reflection of their diminished scientific importance. Clearly the European Space Agency's portion of the ISPM will answer certain of the highest priority scientific questions for missions to high solar latitudes, but it will not provide the imaging capabilities that the U.S. spacecraft was designed to accomplish.

We have no comparable partial compensation in the case of VOIR. Our desire to understand the geological processes and the role played by plate tectonics in the terrestrial planets has not diminished in intensity or importance. The highest priority mission to address these questions remains one that can produce a map of Venus with a resolution comparable into the map of Mars provided by Mariner 9, a study that revolutionized our understanding of that planet. The scientific questions that were to be addressed by VOIR remain of the greatest importance. When resources again become available it will continue to be a mission of the highest priority in the competition for new starts.

Of particular concern must be the fate of the planetary program. I am attaching an Academy statement on the scientific importance of planetary exploration. Beyond Galileo we can see no design for continuing planetary exploration. In fact, the drastic reduction of funding for Research and Analysis and for Mission Operations and Data Analysis in the planetary sciences will de-emphasize and largely terminate planetary science research for the near future. The Administration's submitted budget proposal is inadequate to preserve a viable base upon which future activity can be built. The Space Science Board has consistently maintained that planetary exploration is an integral part of our space-science effort--one that makes a vital

contribution to scientific understanding in a wide variety of disciplines. Its loss or indefinite suspension would have serious impacts that range well beyond the limits of solar-system exploration.

The FY 1983 budget proposal will preserve the strength of the national program in optical-ultraviolet and gamma-ray astrophysics. The Space Telescope and the Gamma Ray Observatory address scientific questions of the highest scientific priority in astrophysics. They, together with the extremely important Galileo mission to Jupiter, are the only major scientific initiatives left in the NASA program, and they will make major scientific advances possible.

In addition, the Explorer program remains an important source of high-priority scientific missions. Unfortunately the level of financial support for that program has failed by a large margin to keep up with inflation, and as a result we are faced with many fewer missions than the program was designed to provide. Nevertheless, the Explorer program is extremely important and deserves full support. Augmentation of the Explorer funding has been urged for a number of years by a variety of advisory bodies including the Space Science Board.

Once we look beyond these missions there is little from which to draw comfort. There is little prospect for addressing the hiatus in x-ray astronomy. At one time Spacelab was thought by some to be a critical step in the future of space science. Yet at present there is virtually no money for the development of scientific payloads to be carried aboard the Shuttle. Spacelab experiments of enormous potential have been delayed. For example, the Shuttle Infrared Telescope Facility (SIRTF), which offers a thousand fold increase in sensitivity in some IR bands--with the consequent potential for revolutionary discovery even in its initial Shuttle Sortie Flight--has been removed from the FY 83 budget despite strong support within the astronomical community and NASA. There is now talk of space platforms. Where will the science and applications instruments to be flown on these platforms come from? Who is developing them?

A DECISION POINT IN SPACE SCIENCE

Clearly we are facing a decision point in planetary exploration and, to a lesser but significant degree, in the remainder of the space sciences. Since I do not sense a consensus that it is no longer in the nation's interest to pursue a vigorous and scientifically significant program in space science, the most important question facing us must be, how do we preserve the nucleus of our national ability to carry out such a program?

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The Space Science Board has addressed this issue at some length, and while there are certainly no easy answers, some principles have emerged. The first is that we must continue to analyze the rich data returned from earlier missions. It not only makes no scientific sense not to analyze these results, it is a very poor use of scarce funds to fail to receive the greatest possible return from what has come to be an ever-diminishing number of space missions. Second, we must continue to gather data from those missions that are still producing extremely important results. Two examples of such missions are the Pioneer spacecraft currently exploring for the first time the outer solar system, and the Voyager mission proceeding to Uranus and then to Neptune. A less familiar example, perhaps, is the data that can be used to search for possible variations in the force of gravity--data that can be obtained by continuing to monitor the remaining active Viking lander on Mars. Third, we must support the theoretical studies, laboratory work, and instrument development that will form the basis of future activity, or we will never be prepared to undertake those missions in a cost-effective way.

There has been considerable discussion of the need to develop lower-cost approaches to address the first-order priorities of planetary exploration. The Board agrees that this approach is important; however, the funding sought for advanced planning in the FY 83 budget is inadequate to support the needed studies, and the support for research and analysis is inadequate to maintain a scientific base upon which a restructured planetary effort would have to be built.

Of course, it is necessary to have a framework that identifies the important scientific objectives if such planning activities are to be properly focused. The Space Science Board has worked for the past five years in developing such a scientific framework, and I have included an overview of those strategies as an attachment to this statement.

Space science is facing a critical period in the coming years. Steps must be taken to make optimal use of the data we have in hand and will be obtaining. It is also necessary to ensure that a basis exists from which to undertake the most important activities. The resources needed are not necessarily large, even for these times of great budgetary pressure, but the failure to allocate and to use wisely those resources could have profound effects for the remainder of this century. If Congress determines that the exploration of the solar system remains a goal of high national importance, it should consider asking NASA to bring to it a plan showing how the capability to carry out this effort will be preserved despite budget pressures.

RESEARCH AND ANALYSIS

There are two related budgetary items that address the above concern: Research and Analysis, and Mission Operations and Data Analysis. Data analysis is supported by the latter item through the active life of a mission and for a short time after the spacecraft operations have terminated; after that the remaining work needed to obtain a full understanding of the data returned from a mission must be funded out of Research and Analysis. As the data analysis proceeds, the continuing interaction between the mission investigators and guest investigators leads to new insights into the results and new ways to analyze the data. Hence it is generally true that many years are needed before the full value is extracted from a set of mission data, and a large part of the funding for this must come from Research and Analysis. As an example, in the presence of fierce competition for funds, support for the analysis of lunar samples and other extraterrestrial materials has been continuously halved every two years since the end of the Apollo program. This work is providing basic experimental information on the origin of the solar system and the development of planetary bodies. It also provides the knowledge necessary to plan properly for future exploration, and potential exploitation, of the moon and asteroids.

In the proposed budget in Physics and Astronomy both Research and Analysis and the data analysis part of Mission Operations and Data Analysis have about the same dollar amounts as in the budget two years previously, so that the level of effort will have been eroded by inflation. The situation is more serious than this, however. It is planned to terminate the mission operations activities for the high-energy astrophysical observatories, so that the continuing data analysis for these very productive missions will have to be imposed on the Research and Analysis budget, thereby having an additional serious impact on the normally supported activities. The termination of the mission operations for the Einstein Observatory (HEAO-2), the very successful and spectacular instrument that has been responsible for an enormous advance in x-ray astronomy, is clearly very premature, since a Guest Observer program for the data from that mission will have to be eliminated. To maintain this program in a healthy condition would require $0.5 million in FY 83. The fiscal pressure on the balloon program may prevent flying the important instrument that had to be eliminated from the Gamma Ray Observatory for fiscal reasons.

Not only is it very important to obtain a full measure of scientific return from the investment in previously terminated missions, but it is vital, in the absence of new mission starts, to maximize the value of the return of data from spacecraft that

are continuing to operate in space. It is thus particularly disheartening to see that the proposed FY 83 budget requires the termination of data gathering from all operating Pioneer spacecraft. The total Pioneer program requires about $8 million per year. Of this, only a small amount is required to maintain data gathering from Pioneers 6 through 9. About $2 million per year is required for Pioneers 10 and 11, and the remainder of the funds support Pioneer Venus (the spacecraft currently in orbit about Venus).

The total scientific return from Pioneers 10 and 11 has already been truly enormous. These spacecraft continue to yield unique data on the solar modulation of cosmic-ray intensity and the acceleration of charged particles in the interplanetary medium. There is in addition a major scientific objective that remains for these spacecraft. This is the discovery of the position and properties of the so-called "heliopause," the boundary between the solar-wind region surrounding the sun and the normal interstellar medium between the stars. Both Pioneers 10 and 11 are heading rapidly out of the solar system, and it is expected that they will cross and measure the heliopause boundary within the next few years (some scientists are surprised that Pioneer 10 has not already done this). These measurements are of major interest to the space plasma-physics community and to the cosmic-ray-physics community, and their loss would be a tragedy. The IMP and ISEE spacecraft still operating provide, among other data, the only measurements of the solar wind and particle and field environments in the outer regions of the Earth's magnetosphere. Not only is the continued acquisition of these data important scientifically, but it may also have important practical ramifications. Changes in solar-wind conditions produce geomagnetic disturbances that cause the aurora and, at times, disturbances in terrestrial power and telecommunication systems. Data acquisition from the spacecraft would provide the United States important measurements of its global environment.

The larger amount of support required to maintain Pioneer Venus is a measure of the important continuing activity with this spacecraft. There is an important guest investigator program that continues to investigate the properties of the upper atmosphere of Venus. Not only would this be terminated, but the funds explicitly set aside for all the data analysis from Pioneer Venus would be eliminated. If the Pioneer Venus mission can be continued, the benefits to the total scientific community will be greatly enhanced through correlative measurements made of Pioneer Venus data with the data returned from the upcoming Soviet spacecraft missions to the planet. Furthermore, during the forthcoming appearance of Comet Halley, the comet will pass within 10 percent of the sun-earth distance of Venus. Such mea-

surements as could then be made of the properties of the Comet Halley gaseous tail by Pioneer Venus are the only remaining chance for an American spacecraft to contribute to the extensive international activities to send spacecraft to Halley.

Another existing mission that continues to be of great importance is the operation of the Thomas A. Mutch Memorial Station upon the surface of Mars. The data that continue to be returned from this station are not only important for their information about Mars, but contributes in a vital way to the improvement of our knowledge of the properties of general relativity that govern the structure of the universe within which we live. The proposed FY 83 budget does not contain the $0.3 million needed to keep this activity going.

The curtailment of the Research and Analysis and Mission Operations and Data Analysis funds for planetary sciences within the FY 83 budget can only be described as disastrous for this discipline. The level of funding is down to nearly half of what it was in FY 81, and this, combined with the lack of adjustment for inflation, will have a far-reaching impact on support for planetary sciences. If these outs are sustained, between 25 and 50 percent of the normal support activities in the various planetary-science program offices will have to be eliminated.

The proposed budget would require the elimination of support for the Infrared Telescope in Hawaii (IRTF), which provides vital ground-based observations in support of the planetary-science program. IRTF continues to provide critical mission planning data for the Voyager spacecraft and is a necessary complement to the Galileo mission. In addition, it provides a testbed for development and refinement of IR instrumentation for future planetary sciences and astrophysics missions. At a time when there are unlikely to be new planetary-science mission starts for several years, a facility such as this provides important new data that allow continuing scientific work in the planetary sciences community and enrich our understanding of the data collected from spacecraft. Operating the telescope would require $1.5 million per year.

Of particular concern is continuing support for the Lunar Sample Curatorial Facility at the Johnson Space Center. Not only does this facility exercise curatorship over much of the lunar sample collection, but it also is responsible for an important part of the meteorites in the United States, namely those collected in recent years from Antarctica, where environmental conditions have both concentrated the meteorites (making them easier to find) and minimized the effects of weathering on them. This facility is vital for the continued research on extraterrestrial materials that is supported by both the NSF

and NASA. An important new function is the collection of interplanetary dust particles in the Earth's atmosphere. These particles are generally believed to be largely derived from comets and represent a totally new approach to the study of these primitive objects. To maintain minimum operations requires $0.8 million per year; to maintain proper curatorial activities requires double that.

The effects of eliminating up to 50 percent of the ordinary research and analysis programs from the planetary-sciences offices can only be described as a widespread tragedy for the disciplines involved. We will not receive a full scientific return from the recent investments that we have made in planetary-science missions. We will not be able to provide the needed support for theoretical studies and laboratory work required for a proper understanding of the returned data. We will not be able to invest in instrument development and mission studies in order to plan cost-effective and science-effective missions for future new starts.

The deficiencies in Research and Analysis and Mission Operations and Data Analysis funding in the space sciences fall particularly heavily on the academic space-science community. University scientists are especially productive in the generation of new scientific and technological ideas, and they have the task of inspiring and instructing the new generations of young scientists. The space program can ill afford the damage that the proposed FY 83 budget would do to this university community.

Attachment A

THE U.S. PLANETARY SCIENCE PROGRAM

The space-science program is a significant factor in maintaining the nation's continuing leadership in science and technology. Space science endeavors throughout the solar system make crucial contributions to the advance of both science and technology. The United States' Aeronautics and Space Act specifies that exploitation of the nation's capability in space to advance scientific understanding of the Earth, of the solar system, and of the universe as a whole is to be an essential activity of the National Aeronautics and Space Administration. This mandate is consistent with sustained efforts to investigate the character, evolution, and origin of these systems as well as to ascertain the character of natural laws and the ways in which these laws act to shape the world around us. The resulting investigations are of great significance in the history of modern science. Furthermore, information gathered through research in each of the major areas of space science is basic to the growth of our knowledge. Most of the important scientific questions are interrelated; continued increase of our knowledge in these areas demands the kind of broad approach to scientific questions that is contained in the integrated recommendations put forward by the Space Science Board during the past 23 years.

Accomplishments and discoveries of the two-decade-long solar-system exploration program have contributed fundamental information to our picture of the world and have stimulated the development of ideas about the nature of phenomena in the solar system and beyond. These first exploratory endeavors have left a legacy of important questions. The goals of planetary exploration are: to discover clues about the events and processes that led to the formation of the solar system; to understand how planets behave and evolve and how their environments were formed; to discover the limits of stability of terrestrial environments; to learn what physical and chemical conditions lead to the appearance of life; and to discern how physical laws act under conditions that are neither achievable in the laboratory nor otherwise directly accessible.

In addition to making such basic contributions to scientific knowledge, planetary exploration constitutes one of the great endeavors of civilization. Our exploration of the solar system is producing an extension in the reach of human experience that has only a few precedents in human history; the ultimate consequences of this expanded compass of knowledge and experience are not yet clear, but no doubt they will be large.

The question has been raised whether the planetary investigation program already has accomplished most of its important goals and thus has little remaining to do of primary scientific significance. During recent years the Space Science Board has repeatedly called attention to important new primary scientific goals in planetary investigations as well as in other areas of space science. The results of scientific space explorations carried out by this nation as well as by others have revealed clearly the significance of the scientific questions addressed by the planetary program. The program continues to address fundamental questions of science, and most of the data returned could be obtained in no other way.

Few other scientific activities arouse similarly widespread popular interest, but popular interest simply complements the depth of the scientific activity.

The Continuing Challenge

Certainly one of the major objectives in modern science is to comprehend the origin and evolution of our own solar system, and then to comprehend more generally the formation of stars and planets in the Galaxy and in the Universe. Large conceptual advances have been made in recent years. Our picture of the general conditions and circumstances of star formation has been sharpened by numerous telescopic studies of stars and the interstellar medium, while at the same time our detailed knowledge of the solar system has grown explosively, considerably sharpening our understanding of this system's history. Abandoning either of these paths of investigation would greatly inhibit continuing growth of knowledge. For example, a question of the deepest intellectual and philosophical significance is whether habital systems such as our own are nearly unique in the Universe or rather are commonplace. This question cannot be approached without scientific attacks on both the astronomical issues and the solar-system questions. This is a particularly clear example of the need for a broad and unified approach to major questions of cosmic science--but it is only one of many examples.

We have in front of us a potentially fertile class of spacecraft investigations that has not even begun, aimed at elucidating the origin of the solar system. Comets and asteroids are believed to constitute the best preserved and most primitive remnants of the matter from which the solar system formed. Detailed study of these objects and their constituent material promises to reveal crucial and unique information about the origin of the solar system--information that can be acquired in no other way.

Even for the Earth sciences, answers to many of the major questions will depend on our deepening comprehension of the planets. The underlying organizing principles for our understanding of many geophysical phenomena are contained in our ideas about continental drift--or plate tectonics--and its connection to the slow convective motions of Earth's mantle material. Yet the circumstances that are essential to producing these fundamental Earthly phenomena are not well understood. By way of comparison, both Venus and Mars are similar to the Earth in size and composition, as well as location in the solar system. Mars apparently evolved through a totally different tectonic regime; Venus may yet be different from both Earth and Mars--we will never know without a detailed study of the structure of the Venusian surface. Our understanding of the global processes that shape planets, including the Earth, will remain incomplete until we have achieved a unified understanding of the terrestrial planets as a class.

Similar and perhaps more crucial challenges to our understanding confront us on the surface of Mars. The scars on the surface of the planet tell of a dynamic history. Mars evidently has gone through large changes of climate and environment during its history. How susceptible is the Earth to similarly large environmental change, and what physical circumstances may precipitate it? Such questions press at us more and more insistently as our own influences on the Earthly environment grow ever larger and more numerous.

Investigations of the outer planets have begun well with the Pioneer and Voyager exploratory missions. We are beginning to ~~frame significant~~ scientific questions for continuing studies in that part of the solar system. The large variations in composition among the four giant planets clearly carry information about processes that formed the solar system. There are major questions about how the similarities and differences among the satellite systems of the outer planets relate to their formation and to that of the planetary system. We are taking early steps toward extracting the information that these objects hold. Intensive study of Jupiter and its satellite system would be an excellent first step to that end.

As we have continued exploration of the planetary system, new questions have come into focus and ways have opened to gain the answers to long-standing questions. Although confident prediction of what new avenues will open in the course of contained research is impossible, planetary science is in the midst of a most fruitful era--one in which new efforts are consistently rewarded by new knowledge and insights.

As elements of the nation's program in planetary exploration, the Space Science Board views the continuing Galileo mission to Jupiter and the deleted VOIR mission to Venus as addressing scientific objectives of the highest priority. The Board's Committee on Planetary and Lunar Exploration is studying the extent to which less elaborate missions can achieve some major scientific objectives. A flexible approach to planetary exploration, relying on a variety of spacecraft missions ranging from large comprehensive missions to simpler missions of more modest cost, may be able to achieve the scientific objectives and provide the programmatic flexibility needed to respond to budgetary exigencies.

The Space Science Board also believes that steps should be taken to identify areas of potential international cooperation in space science. Such cooperative endeavors, using pooled resources in areas of mutual interest and complementary capabilities, could be beneficial to both sides. Successful cooperation will require that both sides maintain independently viable programs as well as stable and confident commitments to agreed upon objectives.

Each Administration and each Congress is faced with difficult decisions on the overall level of support of science and the allocation of funds between scientific fields. In this regard there is no evidence that the planetary exploration program has exhausted its major objectives. The outstanding objectives of this area of science and exploration reflect first-order scientific questions of the highest intellectual significance. The scientific and technical value to society argues forcefully for serious consideration of this field in the distribution of federal research funds.

Attachment B

STRATEGIES FOR SPACE SCIENCE

Since 1975, the Space Science Board has worked with its committees to define scientific strategies looking forward approximately 10 years and attempting to identify the most important areas in which significant progress can be made. These strategies are designed to provide a framework within which detailed mission design and development can occur. The remainder of this document outlines the highlights of the strategies developed to date.

SOLAR-SYSTEM EXPLORATION

The Space Science Board's Committee on Planetary and Lunar Exploration (COMPLEX) has formulated a strategy to guide solar-system exploration over approximately the next decade. The strategy is divided into three integrated parts: the inner-solar-system planets (Mercury, Venus, Earth and its moon, and Mars); the outer-solar-system planets (Jupiter, Saturn, Uranus, Neptune, and Pluto); and comets and asteroids. This division is based on fundamental characteristics of these three classes of objects. Most of the outer-solar-system planets apparently formed at low temperatures and trapped large quantities of volatile material from the preplanetary nebula. The four rock and metal planets of the inner solar system consist primarily of minerals that condense at relatively high temperatures and that apparently accreted to form planetary bodies without carrying along large quantities of highly volatile substances. The planets of both the inner and outer solar system have in common the quality of having formed with enough internal energy to drive continuing evolution. This energy has erased evidence of the formation processes and altered the character of planetary material since the time of formation. By contrast, the smaller solar-system objects--especially comets and asteroids--did not contain enough internal energy to maintain their evolution. In these bodies the character of solar-system material at the time of formation is relatively well preserved; also, evidence of early energy sources and metamorphic processes, which have been obliterated on planets, are apparently preserved in some of these primitive bodies.

For the decade running through 1985, COMPLEX recommends that outer-solar-system exploration extend to Uranus. The targets for investigation in this time period are Jupiter, Saturn, and Uranus, along with their satellite systems. A recommended level investigation of Jupiter was accomplished by the Pioneer and Voyager spacecraft, and the committee recommended that a major undertaking during the decade be an exploratory investigation of Jupiter, its satellite system and magnetosphere. The primary recommended objectives are to determine the chemical composition

and physical state of Jupiter's atmosphere and satellites and to explore the planet's magnetic field and energetic particle fluxes. The Galileo mission, being developed to accomplish these objectives, will employ an atmospheric entry probe as well as a Jupiter orbiter that will explore the magnetosphere and make numerous close passes to several satellites.

The committee also recommended that reconnaissance-level investigations of both Saturn and Uranus be accomplished during the decade. Aspects of these recommendations are expected to be satisfied through planetary fly-bys involving the Pioneer and Voyager spacecraft. Looking forward, COMPLEX regards exploratory investigation of Saturn as the next step in continuing study of outer solar system beyond 1985.

For the inner solar system, reconnaissance-level investigations are completed, and COMPLEX recommends that the strategy focus on Venus, Earth, and Mars. This choice is based on the belief that these three bodies pose a fundamental and well-defined challenge to our understanding of planets. The atmospheres of these bodies span a range of 10^4 in density; Mars' atmosphere is about one hundredth of Earth's; Venus' atmosphere is about one hundred times that of Earth. These differences are large in comparison with other variations in the planetary properties as we perceive them. The differences are intriguing since they reveal widely divergent evolutionary paths of three planets whose early history and formation were similar. The "air"-less bodies of the inner solar system, Mercury and the Moon, are relegated to a lower priority for the decade.

Since the Viking mission to Mars, we know more about that planet than any other except Earth and the Moon. Our investigations of Mars have posed new questions that challenge our understanding in important ways. The recommended primary objectives include establishing the composition, chemical, and physical character of the surface in its many domains, determining the nature and chronology of surface-forming processes and the inventory and distribution of volatile substances, exploring the structure and circulation of the atmosphere, exploring the character and dynamics of the interior, and establishing the planet's state of magnetism and its solar-wind interaction.

Venus has recently been investigated by the Pioneer-Venus mission, which studied its atmosphere and solar-wind interactions through the use of several atmospheric probes and orbiting spacecraft. The major science objectives recommended to carry Venus investigation through the decade to 1987 are to obtain a global map of the Venusian surface in sufficient detail to determine the processes that have shaped its topography, to ascertain the composition of the planet's surface material and

its interaction with the atmosphere, and to explore important photochemical processes in the atmosphere that are analogous to processes in the Earth's atmosphere.

Maps of planetary surfaces have a profound impact on our understanding, because those surfaces contain records of the dominant processes that have sculpted the terrestrial bodies. For example, maps of Mars reveal earlier episodes of erosional processes that cannot occur in the present Martian climate. Conditions on Mars must have been very different in the past and this raises questions about the stability of planetary environments. Venus is shrouded in clouds, its surface hidden until only recently when the earth-based and Pioneer-Venus orbiting radar revealed the first pictures of Venusian topography, which is distinctly different than that of the Earth and Mars. An important goal for the next decade of studies on the inner solar system is construction of a more detailed map of Venus' surface using larger orbiting radars.

Investigation of comets and asteroids will provide essential information about early processes in the solar system. Comets are generally believed to have formed in the outer portion of the solar system, at least beyond the orbit of Saturn, where temperatures may have been low enough to preserve some chemical record of the initial solar nebula. Their chemical composition represents important information about the pre- and early solar system. Asteroids are usually thought to have formed within the orbit of Jupiter, and the greatest bulk of current asteroids now lie in a belt between the orbits of Mars and Jupiter. Current evidence indicates that there are structural and chemical variations across the belt, thought to reflect the conditions of the solar nebula at the time of their formation.

The primary scientific objectives for cometary exploration through 1990 are to determine the composition and physical state of a comet nucleus, the processes that govern the transition of volatile material from the solid nucleus to the gas or atmosphere surrounding the nucleus, and to study the interaction of the comet and the solar wind. To accomplish this, it will be necessary to observe the comet's changing state during its closest passage around the Sun. The recommended objectives for asteroid exploration through 1995 are to determine their composition and bulk density, to investigate their surface topography, and to determine their internal properties.

In order to address these primary objectives, rendezvous mode investigations are required; in the case of comets, with at least one active comet, and in the case of asteroids, with a number of asteroids to sample their diversity.

ASTRONOMY AND ASTROPHYSICS

Exploration continues to play a paramount role in astronomy. Information about distant parts of the Universe is meager, while unexpected phenomena are still being discovered even in the Sun, and in our own and relatively nearby galaxies. Despite the incompleteness of our knowledge, the discoveries and the explorations are made within a general understanding shared by the vast majority of astronomers. This commonly accepted "Grand Design" serves as a framework into which astronomers try to fit new discoveries. At the same time, the general conceptual framework may need to be modified as a result of new discoveries and theoretical insights.

Each field of science develops techniques appropriate to its problems. Astronomy, by virtue of the vastness of the Universe and our inability to perform experiments on it, of necessity has been the most purely observational science. It proceeds by looking at the richest feasible selection of objects across the widest possible range of wavelengths, first to discover what exists, then, by classifying and comparing, to begin to understand. Insight begins to come with the creation of theoretical models based on and interactive with the best available physics. Astronomy has often stretched physics to its limits and now promises to test it in realms beyond the hope of laboratory work. The space-astronomy programs developed in the remainder of this document stress these essential aspects of the field:

- The discovery of novel entities, frequently as a result of opening up new ranges of observation;
- The finding of many examples to permit classification and study of interrelationships;
- The detailed analysis of selected members of the group by each available technique;
- The development of theoretical models; and
- The carefully conceived observational tests of the evolving theoretical framework, even of the physical laws themselves.

To carry out this program requires all the resources of astronomy, with ground-based optical and radio observatories continuing to have a major role. As just one example from many, x-ray binary stars, first discovered by satellite observations, were soon also detected by optical and radio telescopes, and a preliminary theoretical understanding of their nature was worked out rapidly. Even the more familiar objects often need the widest possible range of wavelength of observation for use to really understand their properties. Ideally, if suitably sensitive instruments were continuously available for all spectral regions, our insight into the Universe would

increase dramatically. Although astronomers hope eventually to reach such a goal, at present it is neither feasible nor necessary to do so. What is needed is an orderly progression of inquiries into the diverse objects and effects, near and far, that populate the cosmos. Some can be carried out with existing technology, while others require extensive development.

The recommended detailed strategy is based on many considerations. Foremost are the scientific questions--the quantity and quality of fundamental results to be expected and their relevance to other fields of astronomy and science or to important applications. But the science develops in a context of constraints. The strategies take account of spacecraft development, propulsion capability, and new instrumentation, also of scheduling within the ongoing space program, the continuity of effort within the various scientific disciplines, and budget limitations.

The strategy for the decade has as its focal point the establishment of long-lived observatories in space. The Space Telescope will provide a tool of unprecedented power for uv- and optical-astronomy. The Gamma Ray Observatory will provide the capability from the first systematic study of the Universe at very high energies. Later in the decade, the planned Advanced X-Ray Astronomy Facility will provide the mature observatory necessary to explore the richness of the x-ray sky revealed by the Uhuru and Einstein satellites.

With appropriate support, the decade will also witness the exploitation of the enormous advantages of space for IR astronomy. Cooled telescopes, free of the obscuration and thermal background of the Earth's atmosphere, will carry out deep surveys and detailed studies of star-forming regions, galactic nuclei, and interstellar clouds. An explorer (IRAS) to be launched in late 1982 will perform an initial survey of the IR sky. A planned Shuttle Facility (SIRTF) promises gains of 100-to-1000-fold in sensitivity compared with existing instruments. Later in the decade, astronomers are planning an instrument for studying the wavelength range between 0.1 and 1 mm--a region well-suited for study of star-forming regions and the flux from external galaxies.

Three major Explorers are planned that will carry out fundamental surveys: the Cosmic Background Explorer (COBE) will study in detail the background radiation presumed to arise from the primordial fireball; the Extreme Ultraviolet Explorer (EUVE) will provide a survey of the sky between the x-ray and ultraviolet regions; the X-Ray Timing Explorer (XTE) is planned to obtain high time resolution studies of selected x-ray sources

in order to explore the physics of extraordinarily compact objects such as neutron stars.

These missions will permit astrophysicists to exploit the major advantages of space in permitting the study of objects over broad energy ranges, at high sensitivities, and with fine spatial and/or time resolutions. Astronomy is at the stage where the discoveries and observations needed for major leaps in understanding require the specific tools described in this strategy.

SOLAR SYSTEM SPACE PHYSICS

The sciences we now call collectively solar and space physics began their development early in the history of Western thought. The ancient Greeks were puzzled by the "fire" in the upper atmosphere that today we call the aurora. Galileo discovered sunspots in 1612, and in the succeeding centuries it was established that the number and size of sunspots increased and decreased with approximately 11 year-periods. Moreover, there proved to be correlations between the spots on the Sun, the intensity and location of the aurora, and fluctuations in the Earth's magnetic field. Until recently, neither experimental nor theoretical understanding was sufficient to provide any reason based on physics for the mysterious relationship between activity on the Sun and auroral and magnetic activity at Earth.

Twenty years of space research have given us a physical basis to address this relationship. The Earth has an atmosphere, above the one we breathe, made of electrically conducting, ionized gas--a plasma. Since the Earth's magnetic field controls the structure of this plasma atmosphere, we call it the magnetosphere. The Sun's outer atmosphere--the corona--generates a magnetized plasma wind that blows throughout interplanetary space and interacts with each of the planets. At Earth, this interaction causes strong highly variable motions within the magnetosphere and fills it with solar-wind plasma. Recently, we have begun to understand how the solar wind is related to the structure of the magnetic fields in the corona and to the processs generating these fields in the solar interior. Moreover, we have realized that solar-wind-generated magnetospheric activity drives strong winds in the Earth's upper atmosphere. Thus, whereas once we knew only that auroras intensify when there are sunspots, we now perceive the chain of interactions that links events at the Sun's surface to the solar wind and, hence, to the magnetosphere and atmosphere, only one of whose consequences is the aurora. This interaction chain may extend deeper into the atmosphere. Whereas 10 years ago it was generally believed that significant effects of solar

variability penetrate only as far as the upper atmosphere, some scientists now suggest that they also reach the lower atmosphere and so affect weather and climate in ways not yet understood. Although the sunlight intercepted by the Earth is the only obvious agent connecting the sun with weather and climate, the question of a more subtle solar-terrestrial influence, while still controversial, is so important that we must try to answer it.

Solar-system space research is becoming a quantitative science. As a consequence, it is now yielding useful understanding of solar-terrestrial effects on technological systems in space and on Earth. One example is understanding the effects of ionospheric variability on radio communication. Another is understanding the disruptions of electric power grids and pipeline monitoring systems, and the spacecraft component failures, that take place during magnetic storms. The increasingly quantitative nature of our understanding also means that solar-system space research now makes important contributions to basic plasma physics, in areas such as magnetic field-line reconnection, which is thought responsible for explosive energy releases in solar flares, magnetospheric substorms, and fusion devices.

Twenty years of space research have taught us that the physical processes that we study at the Sun, in the solar wind, and at the Earth, occur throughout the solar system and indeed the astrophysical universe. We now study the interactions between the planets (and comets) and the solar wind in mutually reinforcing ways. Our experience with the Earth's magnetosphere was essential first to design the recent Pioneer and Voyager studies of Jupiter's magnetosphere and then to understand their results. Understanding how the Sun and planets generate their magnetic fields may help to explain why magnetic fields are so prevalent throughout the Universe. Stars like the Sun that have convective outer layers are inferred to have stellar winds; more massive stars have winds driven by radiation pressure. Plasma winds may also be generated in globular clusters and galactic halos; relativistic winds have been proposed for pulsars and radio galaxies. Thus, the term "magnetosphere" is used not only for the Earth and planets but also for the environments of x-ray sources, pulsars, and radio galaxies.

Two basic principles guided the design of the strategy for solar-system space physics. The objectives of solar-system space research are to understand the physics of the Sun; the heliosphere; and the magnetospheres, ionospheres, and upper atmosphere of the Earth, other planets, and comets. Studies of the interactive processes that generate solar variation and link it to the Earth should be emphasized, because they reveal basic physical mechanisms and have useful applications. Quantitative

understanding of the solar-terrestrial interaction chain can provide a better basis for answering the question of whether solar variability affects weather and climate.

To understand better all the processes linking the solar interior to the corona, we need to study: the Sun's global circulation, how it reflects interior dynamics, could modify luminosity, and is related to the solar cycle; the interactions of solar plasma with strong magnetic fields--active regions, sunspots, and fine-scale magnetic knots--and how they cause the release of solar-flare energy to the heliosphere; and the solar corona's energy sources and the physics of its large-scale weak magnetic field.

The solar wind has been studied near the Earth since 1961. In the past decade, measurements of the solar wind in the ecliptic plane were extended to within Mercury's orbit (0.3 A.U.) and beyond Saturn (9.5 A.U.). Quantitative models of high-speed solar-wind streams and flare-produced shocks were developed and tested against data obtained near the ecliptic. The realization that high-speed streams originate in the rapidly diverging magnetic-flux tubes of coronal holes reoriented much solar-wind research. The sector structure of the solar wind was related to a magnetic neutral sheet of solar-system scale that connects to the large-scale magnetic field of the rotating Sun. Finally, microscopic plasma processes were shown to regulate solar-wind thermal conduction and diffusion and, possibly, local acceleration of particles in solar-wind structures.

To understand better the transit of energy, momentum, energetic particles, plasma, and magnetic field through interplanetary space, we need to study: the coronal processes that govern the generation, structure, and variability of the solar wind; the three-dimensional properties of the solar wind and heliosphere; and the plasma processes that regulate solar-wind transport and accelerate energetic particles throughout the heliospere.

Our understanding of many individual processes became more quantitative. The coupling of magnetospheric motions and energy fluxes to the thermosphere was observed and modeled. Currents flowing along the Earth's magnetic field and connecting the polar ionosphere to the magnetosphere were found to create strong localized electric fields at high altitudes. These fields may accelerate the electrons responsible for intense terrestrial radio bursts and auroral arcs. Thus, the problem of auroral particle acceleration is nearing quantitative understanding. By contrast, the relationship between energy circulating in the magnetosphere, the energy dissipated in the

atmosphere, and the state of solar wind could not be understood much more quantitatively in 1979 than in 1969.

To understand better the time-dependent interaction between the solar wind and Earth, we need to study: the transport of energy, momentum, plasma, and magnetic and electric fields across the magnetopause; the storage and release of energy in the Earth's magnetic tail; and the origin and fate of the plasma(s) within the magnetosphere; how the Earth's magnetosphere, ionosphere, and atmosphere interact.

To understand better the entire upper atmosphere as one dynamic, radiating, and chemically active fluid, we should study: the radiant energy balance, chemistry, and dynamics of the mesosphere and stratosphere and their interactions with atmospheric layers above and below; the worldwide effects of the magnetosphere's interaction with the polar thermosphere and mesosphere and the role of electric fields in the Earth's atmosphere and space environment; and the effects of variable photon and energetic particle fluxes on the themosphere and on chemically active minor constituents of the mesosphere and stratosphere.

To understand better the effects of the solar cycle, solar activity, and solar-wind disturbances upon Earth, we need to: provide to the extent possible simultaneous measurements on many links in the chain of interactions linking solar perturbations to their terrestrial response and create and test increasingly comprehensive quantitative models of these processes.

To clarity the possible solar-terrestrial influence on Earth's weather and climate, we need to: determine if variations in solar luminosity and special irradiance sufficient to modify weather and climate exist; ascertain whether any processes involving solar and magnetospheric variability can cause measurable changes in the Earth's lower atmosphere; and strengthen correlation studies of solar-terrestrial, climatological, and meteorological data.

To understand better the interactions of the solar wind with solar-system bodies other than Earth, and from their comparison learn about astrophysical magnetospheres in general, we need to: investigate <u>in situ</u> Mars' solar-wind interaction in order to fill an important hole in comparative magnetospheric studies--previous missions provided little such information; make the first <u>in situ</u> measurements of the plasma, magnetic fields, and neutral gases near a comet; increase our understanding of rapidly rotating magnetospheres involving strong atmospheric and satellite interactions, by orbital exploration of Saturn; and illuminate the role of atmospheres in substorms

and other magnetospheric processes by orbital studies of Mercury--the only known magnetized planet without an atmosphere.

GRAVITATIONAL PHYSICS

Gravity is exceedingly weak on the scale of atoms--far weaker than the other three forces of Nature ("electromagnetic," "strong," and "weak"). However, on larger scales where the other forces "saturate," gravity dominates. Consequently, the larger the scale of an experiment, the more effectively it can probe the laws of gravity. Earthbound experiments are moderately good probes; but experiments in space--making use of the Earth's full gravitational potential and the much stronger gravity of the Sun--are much better probes. Thus, it is that probes of the laws of gravity fall largely within the province of NASA, while probes of the other laws of physics are mounted by Earthbound agencies.

Most but not all physicists believe that the laws of gravity, as formulated by Einstein in his general relativity theory, are likely to be correct everywhere except in the big-bang origin of the Universe and at the very centers of black holes. But experiment must be the ultimate test of Einstein's laws. Before the space program was created, Earthbound experiments had tested one non-Newtonian prediction of Einstein's theory, the red shift of light climbing up through the Earth's gravitational field, to an accuracy of 1 percent, and had tested others to accuracies of about 10 percent. By the end of the 1970's, radio tracking data from many different spacecraft and laser beams reflected from corner reflectors placed on the moon by the astronauts had improved these tests one-hundredfold and had created important new tests. But at the same time, astronomical discoveries (quasars, pulsars, cosmic fireball radiation; neutron stars and tentative evidence for black holes) were making it more crucial than ever that we know whether Einstein's laws of gravity are correct.

The Space Science Board's Committee on Gravitational Physics, guided largely by the needs of astronomers in deciphering the mysteries of the distant Universe, established two rank-ordered lists of scientific goals for NASA's Gravitational Program in the 1980's. The first list involves a class of experiments that either require a dedicated spacecraft or have a major impact on a spacecraft; the second list contains experiments involving Earth-based measurements or small additions to spacecraft constructed primarily for other purposes. A brief description of these goals follows.

Just as the electromagnetic force can be broken into two pieces, electricity and magnetism, so according to Einstein, the gravitational force can be broken into three pieces, one electric-like, one magnetic-like, and one a "curvature of space." The electric-like force and the curvature of space have both been probed by past experiments; but no experiment has ever clearly verified the existence, much less the details, of the magnetic-like gravitational force. That force is exceedingly weak in the solar system but is predicted to be ultrastrong near a rotating black hole and is theorized by many astrophysicists to be the ultimate agent by which supermassive black holes store energy and use that energy to power quasars. Thus it is crucial for astrophysics to verify the existence of the magnetic-like gravitational force and test Einstein's predictions of its details. The one way in which we can do this in the 1980's is by measuring the "dragging of inertial frames by the Earth's rotation"--a manifestation of the magnetic-like force. This can be done using superconducting gyroscopes flown in a specially constructed Earth-orbiting satellite, NASA's proposed Gravity Probe B. Such an experiment has been given first priority in the special-spacecraft class.

The second priority is an experiment to measure the "gravitational quadrupole moment" (i.e., gravitational flattening) of the Sun--a crucial unknown input into the interpretation of past experiments on the "nonlinear superposition" law of gravitational fields and also a phenomenon of interest in its own right for solar physics. The third priority is a measurement, for the first time, of the "nonlinear" effects of gravitational fields on the ticking rates of clocks. These two experiments, solar flattening and clock ticking, might be carried out by NASA's proposed "Starprobe" mission; the solar flattening might also be measured by several years of tracking of a spacecraft in orbit around Mercury.

In the second category, experiments entailing Earth-based measurements and minor additions to space missions, the highest priority is to utilize effectively every opportunity to improve our knowledge of the orbits of the inner planets--Mercury, Venus, Earth, and Mars--and of the Moon. These orbits contain a plethora of detailed information about the laws of gravity--information encoded in a very precise form that includes details of the electric-like force, the curvature of space, and (in a form hard to decipher) the magnetic-like force; the superposition laws for these forces; and details of any change with time of the universal constant of gravitation. Such a change with time would be crucial for the origin and evolution of the universe but would leave only miniscule imprints in the solar system. The measurement of the planetary orbits requires a painstaking accumulation of data at frequent intervals over tens of years,

data from radio tracking of spacecraft, laser beams, bounced off the Moon, and radar beams bounced off the planets, data that should be accumulated at every opportunity, producing a legacy for future generations to work with.

The attempt to detect cosmic gravitational waves has second priority in the minor-addition class of experiments. Gravitational waves are not only an unverified feature of relativistic gravity; they are also a powerful potential tool for astronomy--a tool that one day may produce a revolution in our understanding of the Universe comparable with that recently produced by Earth-orbiting x-ray telescopes. If the prospects were high for successful gravitational-wave detection in the 1980's by spaceborne systems, gravitational waves would have first priority in the Gravitational Physics Program. Because prospects are small, they have second priority. The goal should be to equip interplanetary spacecraft of the 1980's, constructed for other purposes, with instrumentation [primarily a capability for radio tracking at ~8 gigahertz (X-band) on both uplink and downlink] that is as sensitive as possible to the effects of gravitational waves.

Third priority is the development in the 1980's of new technology and instrumentation for use in gravitational experiments of the 1990's. The highest priority instruments are (a) an improved radio tracking system for spacecraft; (b) an optical interferometer to be flown in Earth orbit for measuring positions of stars to unprecedented accuracies; and (c) design studies for an optical-heterodyne gravitational-wave detector to be flown in space. The radio tracking system and the optical interferometer could be used in experiments that improve a hundredfold or more the accuracy of tests of Einstein's gravitation theory. The optical heterodyne system would have good prospects of detecting and studying gravitational waves from distant binary stars, nova explosions, quasars, and violent galactic nuclei.

EARTH SCIENCE FROM SPACE

This strategy is the first phase of an integrated strategy for earth sciences from space for the decade of the 1980's. It is a basic premise of this strategy that our knowledge of the Earth has expanded to the degree that a unified or global concept must be adopted as the basis for fundamental questions on future exploration. This premise also places the Earth in a planetary perspective. Planet studies have in common: the composition and structure of their surfaces, which provides basic information on their evolution; the dynamics of the surface and interior, which can be directly related to the distribution and

transfer of internal energy and, in some cases, to the tectonic and volcanic activity at the planetary surface; and the reactions that take place on the surface of planets, which gives rise to the composition and dynamics of their atmospheres. Terrestrial oceans are unique within the solar system; knowledge of their dynamics is essential if we are to understand the related problems, more common in a planetary context, of atmospheric dynamics and global climate.

Having placed the Earth in a global or planetary framework, we can identify the fundamental problems that can only, or most efficiently, be addressed by spacecraft in Earth orbit. In so doing we adopted a concept that now allows the Earth to be included in comparative studies with other planets.

The scientific topics in the first phase of the strategy include the dynamics of the solid earth, the geological structure and history of the continents, and the dynamics of the oceans. These three areas are of major importance in our understanding of the basic global processes that have shaped the Earth and will contribute to our ability to deal with such major societal issues as natural resources, natural hazards, and future climate.

These three major areas of study are linked through several scientific goals and objectives. The present surface of the solid earth is the product of many episodes of continental rifting, seafloor spreading, subduction and ocean closure, and continental collisions. The seafloor records the history of such processes only for the last 200 million years. Any earlier record of earth history and dynamics must be found in the mountains' belts, ancient shields and platforms, and the rifts and sutures of the continents. In a broad sense, the large-scale circulation of the ocean is also partly a product of the configuration of the ocean floor. As the seafloor subsides, as continents drift relative to one another, and as global spreading rates vary, ocean sea levels can change, new avenues can be opened for major bottom currents, and the bottom boundary condition will slowly evolve. An understanding of ocean circulation in the geologic past and in the future, and its influence on climate, is closely tied to an understanding of the changes in ocean bathymetry associated with plate dynamics.

In the area of solid-earth dynamics, the primary science objectives involve direct measurement of the present relative motions of the major tectonic plates. Because plate velocities provide a framework for much of our understanding of earthquakes, volcanism, and the origin of mountain belts, testing current concept by direct measurement is of utmost importance. The objectives also include measuring the deformation near plate

boundaries and how it varies in time. Such measurements can greatly aid our understanding of mantle convection, the mechanism that drives plate motion.

In the area of continental geology, the primary objectives include mapping the distribution of surface rock types, their composition, and structure in a global and uniform fashion. This information is essential for deciphering the history of the Earth's crust and for characterizing the geologic setting of areas with potential resources.

For ocean dynamics, the primary science objectives are the determination of the surface boundary conditions for general circulation of the oceans on a global basis, including the sea-surface slope and the wind stress.

The committee regards solid-earth dynamics, continental geology, and ocean dynamics as areas of equal importance for a program of earth sciences from space, and therefore progress toward achieving the recommended objectives in each area over the next decade should be balanced.

The second phase of the strategy will be integrated with the first and will treat climate, atmospheric circulation, the Earth's water budget, and chemical cycles.

PLANETARY BIOLOGY

The Board identifies three objectives as fundamental to understanding Earth as a planet that harbors life. These are understanding: the origin and evolution of life; the cycles that sustain life; and the effects of life, both past and present, on the planet.

It was once believed that only a planet like Earth could provide the conditions under which the complex molecules that make up living systems could arise. We now know that complex carbon containing molecules can be found in such diverse places as interstellar gas and dust, comets, meteorites, and the atmospheres of the outer planets. The continuing study of these and related systems will play a key role in furthering our understanding of how the ingredients of living systems arise. For example, it now appears that the atmosphere of Titan, although very cold in comparison to that of Earth, resembles in many ways the chemistry of Earth's atmosphere before life appeared. Studies of the chemistry of Titan's atmosphere will help us understand the origins of life on Earth.

The next important step in the path toward life is the production of long-chain chemical polymers. Laboratory studies are needed to elucidate how such processes occur. Laboratory work is also needed to understand how the earliest polymers might have interacted to form primitive information-transfering and energy-generating systems. Eventually these primitive systems must have become cells--the minimal systems that can be recognized as being alive. In living systems enzymes are critical to this process. Laboratory studies are needed to understand how the earliest reproducing systems might have been formed without the aid of enzymes.

Many of the processes that arose with the advent of primitive life are still active today. These include the fundamental chemistry of the nucleic acids and proteins that form the basis of growth and reproduction in all living systems. Some two billion years ago life had one of its greatest impacts on the Earth and its surface--sufficient oxygen was released to dramatically alter the planet by creating the atmosphere that we know today, an atmosphere that could not persist in the absence of life. The life forms that contributed to this dramatic alteration can be studied through their fossil remains and through laboratory studies of the relationships among their still living descendants. Both kinds of effort are needed to understand the early stages of life on Earth and the extent to which the present-day appearance of the planet is dependent on the early development of life.

The advent of space technology has provided for the first time the capability to study life and its effects on a global scale. Since life is a global and not a regional or local phenomena, this is of fundamental importance.

The survival of life on Earth is dependent on the existence of an extensive interaction between a variety of systems. For example, we would like to know how the elimination of large sections of the tropical rain forests will affect the rest of life on Earth. Will the elimination of trees effect the amount of oxygen in the atmosphere? Will the increase in carbon dioxide produced by the burning of those trees affect the climate? It has been a concern that industrial gas and chemical emissions adversely affect populations of organisms in the oceans that form the basis of food chains for fish and other marine animals and also contribute to changes in atmospheric oxygen, carbon dioxide, and other gases. We cannot tell whether such effects are potentially harmful until we better understand the relationships between the microorganisms and their environment and the extent to which the living systems in the oceans and forests of the world determine the composition of the atmosphere. It is particularly important to identify and measure the contribution

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of the major species that convert sunlight into plant growth, for this is critical to understanding how close we are to taxing the capabilities of the system that supports life on Earth.

The atmosphere of Earth looks very different from the atmosphere of a planet without life. The most obvious quality is the large amount of free oxygen, but there are other important effects too; and the abundance of such gases as methane and ammonia are controlled biologically. If we are ever to understand the chemistry of the atmosphere and its stability, we will need know to the nature and extent of relevant biological processes. Satellite-based studies will make an important contribution to assessing the role of biological activity in maintaining the global balance of the atmosphere.

As an example of the role that life plays in shaping the surface of the planet, all organisms require mineral elements in order to grow and reproduce; other elements are toxic and retard or prevent growth. This means that rates at which elements move in and out of solid states are critical for biological survival. But biological processes themselves affect the chemistry of minerals, particularly in sediments and the oceans. In order to understand the balance between these processes and to discover if it is changing in any way, it will be necessary to moniter the processes remotely. One way in which this can be done is by surveying large ecosystems such as coral reefs where carbon dioxide is being removed from the atmosphere and converted into limestone.

Since life is a global phenomenon it is not surprising that it takes global resources to understand it. Global biological studies require an understanding of satellite data that must be based on a close familiarity with the conditions that satellites observe only remotely. On the other hand, scientists who understand the way space techniques can be used can make them available to those in need of information to solve local problems. Such an interaction of global and local studies can provide great benefits for those attempting to understand the conditions critically important for human survival. Since many studies of fundamental importance to global research require a magnitude of effort involving scientists from a variety of disciplines and involve data gathering and analysis on a scale that exceeds the capabilities of an individual scientist, or even an entire university department, a coordinated international program would be a natural home for such studies.

SPACE BIOLOGY AND MEDICINE

Space exploration has given two distinct challenges, and opportunities, to the biologist. One could anticipate that weightlessness would subject an astronaut to unique physiological stresses. This has, in fact, proven to be the case. This unique perturbation to our system has provided us with many questions and, to date, a few answers. The fundamental and general nature of these questions has made them relevant to all animals and in several instances to plants.

At the same time that we were focusing our interests on fundamental principles of physiology, we were beginning to see our planet as a single entity. The Earth is unique among planets--unique in water content, unique in gaseous composition, unique in climate, unique in geology--because for over three billion years its elements have been cycling through living cells. We realize that we must understand global ecology in order to understand the basic characteristics of our planet. Inevitably some of the instrumentation and concepts used to study global ecology complement those used to understand our basic physiology.

The Space Science Board's Committee on Space Biology and Medicine considered five aspects of human physiology that are especially critical in spaceflight--Renal and Electrolyte Physiology, Cardiovascular Research, Endocrinology, Vestibular Research, and Genetics and Developmental Biology.

For reasons, still not understood, an astronaut loses several liters of fluid from his legs and passes several liters of urine during the first few hours of weightlessness. The eventual understanding of this fluid balance will not only permit extended spaceflights but contribute to an understanding of the physiologies of other people subject to unique stress--bedridden patients, divers, etc.

The heart functions satisfactorily at zero-g, even though fluid has shifted from the legs to the upper body. When an astronaut returns to the stress of normal gravity he/she faces several days of adaptation before tolerating a normal level of activity. We are trying to understand how increased, and decreased, demands on the heart affect short-term responses such as pulse and stroke volume as well as long-term acclimatizations such as changed muscle mass.

Progressive lose of bone is a major hazard of prolonged spaceflight and of prolonged immobilization. We do not understand the basic cellular and molecular mechanisms of bone deposition and resorption. Whether bones are responding directly

to weightlessness or to altered concentrations of parathyroid hormone or of calcitonin has yet to be determined.

The Spacelab astronauts experienced motion sickness whose characteristics and causes seem similar to those of sea sickness and of car sickness. The integration of different sorts of sensory input, particularly from the vestibular system, is somehow degraded. One can select individuals who are less susceptible to motion sickness and one can find drugs that reduce the effects of motion sickness. However, in order to reduce its occurrance and minimize its impact we must understand the basic principles of sensory input and integration.

When a fertilized egg or the cells of an early embryo divide, their daughter cells, though carrying the same DNA, are destined to develop into different tissues. It has long been suspected that gravity is a critical factor in determining the destines of various cells and their progeny. A gravity-free environment allows us to evaluate the mechanisms underlying one of the most fundamental characteristics of plants and animals, their development from a unicellular to a multicellular organism.

The initial motivation for much of this research was a concern for the welfare and performance of the astronauts. The concepts and techniques have benefited from and contributed to our understanding of basic biology.

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February 24, 1982

Dr. Radford Byerly
House Committee on Science and Technology
Subcommittee on Space Science
Washington, D. C. 20515

Dear Dr. Byerly:

The Executive Committee of the American Astronomical Society-Division of Planetary Sciences would like to submit the attached analysis of the proposed FY'83 NASA budget in the area of Planetary Exploration as part of the record of the committee's hearings.

I would also like to thank you for taking the time to discuss these issues with me last February 9, and also offer any assistance that I can to the committee in its future work in this area.

Yours sincerely,

Michael J. S. Belton

MJSB/elf
Enclosure

AN ANALYSIS OF THE PROPOSED NASA BUDGET
FOR PLANETARY EXPLORATION IN FY'83
DIVISION FOR PLANETARY SCIENCES-AMERICAN ASTRONOMICAL SOCIETY

THE RAW NUMBERS

The Planetary Program consists of three chief parts: (1) Flight Project Development (now there is only Galileo); (2) Mission Operations and Data Analysis (which now mainly supports spacecraft in their extended missions); and (3) Research and Analysis (the base programs in planetary astronomy, geology, planetary materials, etc. which support most planetary research activities, plus some advanced planning and instrument development work). Galileo is at its peak funding level this year (FY '82) and is headed downwards hereafter. Here are the past, present, and proposed budgets for the two base programs of Mission Operations and Research & Analysis:

(millions of $)	Past Year (FY 81)	Current Year (FY 82)	Proposed (FY 83)
Mission Operations	$61.8	$38.3	$26.5
Research and Analysis	$50.7	$46.7	$35.5

If you correct for inflation, you will see that the basic R & A program is being cut in half in just two years. Mission Operations is being cut even more.

WHAT's BEHIND THE FY'83 BUDGET?

In early December 1981, the Reagan Administration decided to terminate planetary exploration. While officials such as Presidential Science Advisor George Keyworth and NASA second-in-command Hans Mark had publicly called only for "cutbacks" and "de-emphasis" of the planetary program, in fact the Office of Management and Budget devised the planetary budget on the assumption that it would be "zeroed out" over 3 years. While the press made hay with the leak that Voyager might be silenced, it is difficult to believe anyone was seriously contemplating such an absurd action. But Galileo was to be cancelled. Apparently Galileo was reinstated in the budget at the last minute, later in December, for reasons that have nothing to do with the merit of the program (California politics, adverse publicity and DOD requirements are thought to be the reasons).

The essential point is that the FY'83 budget for the basic planetary research is exactly the same as it was when it was intended to be the start of a 3-year zero-out. Despite press reports in early February that the President gave the planetary program a "reprieve" and that the program is now doing "pretty well" in the FY '83 budget, there is no evidence in budgetary substance (as distinct from words) that the Administration is deviating from its intent to end planetary research.

WHAT WOULD BE THE IMPACT OF THE BUDGET PROPOSAL ON PLANETARY RESEARCH?

The simple answer is that the FY '83 budget cuts alone would have a devastating effect on the field -- a blow so severe that some doubt whether it would be possible for the activity to recover. Large numbers of first-rate research scientists would be forced into other fields, from which they probably would not return. Existing spacecraft would be turned off forever. At least one major observatory would be closed. The lunar curatorial facility would be closed, with devastating effects on lunar and meteoritic research.

What follows is a brief description of the likely impact of these budget cuts. Some of the closures and program-reductions have already been announced by NASA officials. Others are educated guesses about likely impacts that are being discussed but not yet decided. Note that this is not a shopping list of possible effects. All of the enumerated effects will happen. Or, if a decision is made not to carry out any particular cut, then an equivalent cut would have to be made in some other equally (or even more) vital area of planetary research.

Basic Research Programs (Planetary Astronomy, Geology, Materials, Geophysics/Geochemistry, and Atmospheres)

After slow erosion over several years and a 20% real cut-back in 1982, these programs would suffer sharp further cuts in FY '83. Despite attempts by NASA officials to preserve the people in the scientific community at the expense of major facilities that can be (temporarily, one hopes) mothballed, approximately 100 more of the 600 existing P.I.'s would lose their funding. This would not only force more scientists away from the field, but would also mean disbanding technical staffs, stopping support for students and post-docs, and threatening operations of laboratories and observatories.

Termination of Mars Data Analysis Program

Despite the wealth of quite recent Viking data that has barely been looked at, this productive research effort would be totally shut-off (it was supposed to be $3 million this year). After the stunning success of the Viking missions, America's sudden disinterest in Mars would become complete. Further research on Mars would be possible only at a minimal level, within the context of the basic research programs, which (as described above) are being sharply cut back themselves.

Shut Down of Lunar Curatorial Facility

It is intended that this unique repository for the Apollo moon rocks and Antarctic meteorites be closed down. The only function that would remain would be maintenance of the environmental conditions necessary to preserve the lunar samples. There would no longer be any allocation of samples to the research community or other curatorial activities. The effect would be a nearly total loss of the essential data for lunar sample research and a serious loss of capability for American scientists to study the Antarctic meteorites.

Shut Down of the NASA Infrared Telescope Facility

This telescope, built in the 1970's by NASA, is one of the largest telescopes in the world and one of the most advanced. It is the finest infrared telescope in the world and is located at what is widely regarded as the best observing site in the world: Mauna Kea in Hawaii. Cutbacks in the FY '82 budget already will result in a one-month closure of the IRTF this year. There would be zero dollars to operate the IRTF in FY '83. Some astronomers believe the IRTF could be saved by shifting it to the NSF. This is unlikely, given the severe cutbacks within the NSF that have already resulted in closure of several telescopes on Kitt Peak. But planetary scientists should resist an NSF "solution" anyway, for history has amply demonstrated that NSF-funded observatories can only grant relatively small fractions of their observing time for planetary observing. Some doubt that NASA is serious about closing down the IRTF, but within the context of these drastic budget cuts, the logic is inescapable: the IRTF necessarily is costly to operate and if the $1.5 million were instead applied to further cuts in the grant-research programs, many more astronomers would be put out-of-business. Infrared planetary astronomers require new data, so the intended closure must be viewed as a short, temporary (not permament) measure until sanity returns to the budgeting process.

Halley's Comet Watch and Giotto Experimenters Cutback

America is not sending a mission to Halley's comet. But there is a program of groundbased observation plus a few American co-investigators on the European Giotto mission. The proposed half-million dollar FY '83 cutbacks would make the Halley Watch program a shadow of what had been planned and the Giotto experimenters would be at what are regarded as less than minimally adequate funding levels.

Advanced Studies and Instrument Development

The 25% cuts in level-of-effort on these forward-looking programs would further incapacitate our attempts to develop sound strategies for future planetary missions and to develop state-of-the-art instrumentation for such missions.

Minimal Voyager Jupiter and Saturn Data Analysis Programs

It had been intended to initiate Jupiter and Saturn Data Analysis Programs analogous to the Mars Data Analysis Programs, in order to support the continuing analyses of the Voyager teams and to open the vast wealth of new Voyager data to the wider community of planetary scientists. $4 million was to be budgeted for Jupiter, another $4 million planned for Saturn. Approximately half the money would have supported the Voyager team; the rest would have supported non-Voyager scientists. As proposed for FY '83, Voyager scientists would be supported at only a 75% level and only 25% of the intended funds would then be available for the rest of the community. (For bureaucratic reasons, these data analysis programs are included in the Mission Operations budget under the "Voyager operations" line-item.)

Pioneer Venus Orbiter to be Turned Off

Although Pioneer Venus has completed its nominal mission, an extensive program of unique measurements has been planned to last until 1992, when its orbit decays and it will enter the Venusian atmosphere. As its orbit evolves it can measure the interaction of the solar wind with the planet's environment in ways not possible earlier in the mission. Continued monitoring of Venus cloud motions and gravity are intended. A special set of measurements is planned for the re-entry phase of the mission in 1992. Instead of the $5 to $6 million required, however, zero dollars are budgeted for Pioneer Venus in FY '83. It will be turned off permanently by January 1, 1983, unless the budget is restored. Once turned off, the spacecraft cannot be reacquired.

Pioneers 10 and 11 Also to be Turned Off

These two spacecraft, traveling in opposite directions, are the most distant man-made objects in the solar system. It is hoped that they will penetrate the heliopause and record the first direct measurements of the interstellar medium. For lack of about $2 million in the proposed FY '83 budget, they would be turned off permanently by January 1, 1983.

Diminished Planetary Flight Support

Engineering efforts designed to assist ongoing mission activities (e.g. upgrading computers, designing spacecraft information systems, etc.) would be cut-back. Among other things, this would further pinch the Galileo program.

HOW CAN THE PROGRAM BE SAVED?

Most of the research and operations activities listed above could be saved if $40 million were restored to the budget (approximately $25 M restored to the Research and Analysis programs, about $15 M restored to the Mission Operations category, which

Includes Voyager Data Analysis Programs). This would bring the base efforts back toward the FY '81 level. Most observers regard this as a minimal base effort. Even with such a restoration, many important intentions of the Planetary Program office still could not be carried out, including:

*a research program to study planets about other stars
*the construction of the Spacewatch Camera, designed to discover asteroids
*the proposed Early Crustal Genesis Program
*new initiatives to study cosmic dust in the earth's atmosphere and the Antarctic meteorites.

Michael Belton
Clark Chapman
Laurel Wilkening
DPS-Executive Committee

Statement of Dr. Ray A. Williamson

Space Program

Office of Technology Assessment

To the

Subcommittee on Space Science and Applications

of the Committee on Science and Technology

U.S. House of Representatives

March 2, 1982

OTA appreciates the opportunity to place this statement about private sector involvement in space applications in the record. The Office of Technology Assessment has just completed a broad independent assessment of this nation's civilian space policy.[1] Civilian Space Policy and Applications, which was requested by the parent committee of this subcommittee, analyses the effects of past policies and presents the key issues that face the U.S. space program in planning for the future, with a strong emphasis on applications of technology in space. In the course of our study, we developed some policy alternatives that could strengthen the involvement of the private sector in space technology and thereby enhance the nation's presence in space and in important areas of high technology. This statement is based on that study. The following outlines the context for the U.S. space program in space applications and identifies ways in which the program might be strengthened by involving the private sector more fully in space.

CONTEXT

o **Changed character of international presence in space.** For many years, the United States and the Soviet Union were the only countries capable of reliably placing objects and men into orbit. The space programs of other countries were nearly entirely dependent on the American and Soviet satellites, launchers, and associated tracking and data relay systems. Now, the Europeans, most notably the French, as well as the Japanese, have their own satellites and major launching systems. In addition, India has a small space program, China is developing its capability, and Brazil and Pakistan have recently announced plans to develop their own space programs as well.

o **Competition in space.** The United States now faces stiff direct competition in space from countries that have developed and marketed space technology aggressively around the world. In particular, the French are now marketing their expendable launch vehicle, the Ariane, to compete with the Shuttle, and in 1984 they plan to begin operating the SPOT remote sensing system to compete with Landsat. Making good use of available U.S. technology, the Japanese are developing their own launchers, as well as communications and remote sensing satellites, particularly for ocean surveillance.

The consequence of foreign investment in space is that unless the United States is prepared to commit more of its public and private resources to space than it now does, it will during the '80s be a leader, but not the leader in space applications. Both technological and commercial leadership are at stake. The U.S. leadership position will depend not only or even primarily on spending more money, but on thoughtfully and effectively allocating our technical, financial, and institutional resources to meet international competition.

o **Broad use of space technology.** One of the major reasons that other nations have developed into competitors of the United States is that the use of space technologies has grown profoundly in the last 25 years. Today the world depends increasingly on space for useful or vital public and private services and space manufacturing as well. Data transmission, voice communications and TV broadcasting via satellite have become commonplace. Satellite weather observations, navigation services and national security surveillance also play a significant role in our daily lives. All of these space applications require an adequate space transportation system, including launch vehicles, spaceports, and tracking networks. The new markets these technologies have created are highly attractive to nations that also wish to maintain or extend their expertise in high-technology for reasons of economic benefit or national prestige.

o **Federal Budget Constraints.** Given the likely restraints on Federal spending, the Federal government cannot assume the entire burden of meeting foreign competion. Nor does it need too. Because there are potentially strong commercial markets for space technology, it is important that the private sector participate more actively in U.S. space efforts by investing a greater share of private financial resources, ingenuity and responsibility in space technology.

In its assessment of civilian space policy and applications, OTA reached the following conclusions:

1) **Continued development of space technology by the U.S. will serve the public good.** The success of satellite communications for meeting national and global communications needs is perhaps the clearest example of the truth of this proposition. Aerospace research has also resulted in a number of non-aerospace applications, such as the cardiac pacemaker or advanced gas

turbines, that have created new industries, provided jobs and helped to maintain the U.S. technological edge in world markets. The debate over future aerospace research has tended to focus primarily on the cost of such research without due regard to the potential economic benefits that may result.

2) **The Federal Government has a continuing role to play in encouraging private investment in space technology.** Except for communications technology, the Government remains the chief investor in space technology. This is likely to continue simply because the risks and costs for private investment are still too high and the expected return too far in the future. In addition, the Government will continue to have a strong interest in space technologies because they serve public needs. In 25 years, the U.S. space program has expanded well beyond NASA to include other civilian agencies as well (Table 1). Private interest in space is also higher now than it has been in the past. As more companies recognize that profits are to be made in space, the role of the government as initiator of new projects is likely to evolve into that of responder and supporter of industry needs. The situation maybe likened to commercial aviation before World War II where...

3) **Many applications of technology in space will be appropriate for private development and operation.** As access to space through the use of the Shuttle and other launch vehicles becomes more routine, it is likely that private sector interest in space technology will increase and companies will be less reluctant to invest in it. Communications satellites already support a multi-billion dollar industry. In the near future, satellite remote sensing and space materials processing technologies may offer attractive investment

opportunities. The private sector may also have an important role to play in owning and operating systems presently under government control, e.g., launchers, tracking equipment, launch pad maintenance and control.

4) **A range of incentives to involve the private sector is needed.** Maintaining a high level of R&D activity is only one aspect of the process of commercializing a new technology. Before the private sector can be expected to adopt a new technology it must be economically viable as well as technically feasible. The determination of economic viability involves a complex analysis of many variables (Table 2). Policy initiatives that focus primarily on hardware development may produce technologies which are ill adapted for the commercial marketplace.

The Landsat system appears to be an example of a technology poorly designed for meeting user needs in the competitive environment that the French SPOT system will provide. Future Government initiatives in land remote sensing need to address such considerations as 1) private sector knowledge of and access to world remote sensing markets, 2) whether or not the U.S. Government, presently the largest user of remotely sensed data, can satisy its civilian needs from a private sector source, 3) the possible need, at least initially, for some form of price supports for the infant remote-sensing industry.

INVOLVING THE PRIVATE SECTOR.

In order to accomplish the desirable goal of involving the private sector more deeply, the Government should act to make private access to space attractive and relatively trouble-free. To do this will require developing a number of innovative institutional mechanisms and incentives.

The course of technological innovation from R&D to the marketplace generally includes barriers related to the technical and economic uncertainties of a new process or product. Innovations in space technology face additional barriers related to the expense and technical difficulty of placing men and equipment into orbit. Table 3 lists the most important of these barriers, including those that result primarily from reaching or working in space. It is these barriers to which incentives are directed. Lowering the barriers reduces the economic risk. The importance of any particular barrier will, of course, differ from technology to technology. For satellite communications in the '60s, the market, though unknown in detail, was sufficiently strong to encourage investment; the greater uncertainty lay in the technical operation of the system. For the Landsat system, by contrast, both the operation of the satellite system and the market for data were uncertain. The market remains small and its future growth uncertain, though promising.

The following discussion outlines several mechanisms for involving private investment that have been used in the past and suggests some new possibilities for the future.

o **Joint Industry/Government Research and Development Projects.**

In a sense, any of NASA's or DoD's programs that provide funds for industry to develop new technology that could also find use in commercial applications, act to reduce the barriers to innovation. However, though such work may help some companies, the spinoffs are accidental and generally not under the control of the corporation.

One way of insuring that industry has a genuine stake and early involvement in technological innovation is to design and fund R&D programs in which Government and industry work together on projects of mutual interest. NASA's proposed Ka band (30/20 GHz) satellite communications demonstration project is a excellent example of such a possibility.

As the recent hearings on the proposed 30/20 GHz demonstration project that were held by this subcommittee suggest,[2] Government encouragement of industry participation in a given project or technology is dependent on the structure of the industry and the amount of capital available to undertake long-term projects. In the case of satellite communications, the greatest potential profits from a new technology are likely to be reaped by the firms that lease satellite transponder time (i.e. the broadcast firms) rather than the satellite builders. Hence, the future expected profits accruing to the satellite builders may not be sufficient to allow them to pursue advanced communications research independently.

Satellite builder enter into partnership with broadcast firms

o **Designated Entity.**

One way to involve the private sector in using space technology is to designate a single entity to commercialize technology developed by the government or with government funding. The development of satellite communications by Comsat is an important example of this mechanism. However, there is no single best model for commercializing all space applications technologies. The particular series of steps that led to the Comsat Corporation, for example, though effective in promoting satellite communications, may not prove appropriate for other technologies. Commercializing other space technologies requires that the special circumstances and different requirements of each be considered in determining whether and to what extent a particular system should be operated for profit. Regardless of the means considered appropriate for transfer of Federally developed technology into the private sector, interested industrial participants must be involved in planning for the demonstration phase (i.e., the phase prior to commercialization), in financing, in setting technical specifications, and particularly in articulating the goals of users.

Although designating a single entity to develop a new technology for the marketplace may be appropriate for some technologies, such as satellite communications, and for some markets, it doesn't necessarily satisfy the desire to involve a broad set of industries in space activities. Mechanisms and incentives that appeal to a wide variety of investors of different interests and capital are needed.

o **Tax Benefits.**

It maybe possible to involve the private sector in the development and operation of new space systems by a creative use of the tax laws. Three of the main incentives in the

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present tax system are depreciation allowances, investment tax credits, and the ability to deduct R&D outlays. By tailoring these incentives to apply more generously to research on particular space systems, the private sector may be encouraged to participate in research that might otherwise involve too high a degree of risk. The main advantage to using tax benefits rather than alternative devices to stimulate R&D is that it involves less direct government control.

o **Encouraging Industrial Consortium**

An obvious alternative to the more common case of projects directed by a single firm, is to encourage research joint ventures or industrial consortiums. Such a joint venture would be a formal means to pool resources (financial, technical, and physical) and liabilities among the participating firms. The joint venture could be established by manufacturers with other manufacturers or with subcontractors to do advanced research in space systems. Recently, more than a score of the largest U.S. computer manufacturers and their semiconductor suppliers have formed such consortium under the Semiconductor Industries Association to conduct advanced electronics research.

The U.S. antitrust laws may present certain barriers to such a plan. Whether or not a joint venture violates the antitrust laws is a function of its design and the circumstances under which it is established. The articulation of a clear Government policy encouraging consortia and clarifying their position with respect to the antitrust laws would greatly facilitate their use.

o **The Joint Endeavor and related agreements.** One important area in which a variety of new users might become involved in research in space in the near future is in what has come to be called by NASA, materials processing in space (MPS). The research that has

been done so far by NASA as well as by foreign space agencies has indicated that some products can be manufactured in the microgravity of space with greater precision and fewer defects than on earth. Other products that cannot be made on earth at all may be possible for the first time.

Materials that have very high value and relatively low mass such as some pharmaceuticals, electronic components, optical devices, chemical catalysts and metal alloys may prove particularly excellent candidates for space manufacturing.[3] But first, comprehensive generic research must be done to confirm the potential of these products. The question here is, as in other areas of space technology, how can the Government more effectively involve private interests in space? By involving the chemical, heavy equipment, electronic devices, pharmaceutical and other industries in materials processing ventures, NASA hopes to broaden the base of interest in doing research in space for eventual commercial products.

For this purpose, NASA has developed a range of cooperative agreements to share the cost and risk of early commercial ventures in materials processing.

- **Technical Exchange Agreement (TEA).** This agreement is appropriate for companies interested in applying microgravity technology but who are not ready to commit themselves to a specific space flight experiment or venture. Under a TEA, NASA and a company agree to exchange technical information and to cooperate in the conduct and analysis of continuing ground-based research programs.

- **Industrial Guest Investigators Agreement (IGIA).** In this agreement, NASA and industry share sufficient mutual scientific interest that a company arranges for one of its scientists to collaborate (at company expense) with a NASA-sponsored Principal Investigator on a space flight MPS experiment.

- **Joint Endeavor Agreement (JEA).** This is a cooperative arrangement in which a private sector offeror and NASA share common program objectives, program responsibilities, and financial risk. The objective of a JEA is to encourage early private sector investment in MPS by sharing in the cost and risk of specific initial space ventures and to determine the ability of MPS to meet needs of the market place. Under a JEA, NASA and its partner exchange no funds. The private firm selects an experiment and/or a technology demonstration in compliance with NASA's objectives for its MPS program, conducts the necessary ground investigation, and develops flight hardware at company expense.

  As incentive for a JEA investment, NASA agrees to provide transportation on the Shuttle, provided that the project meets certain basic criteria, such as technical merit, contribution to innovation, and acceptable business arrangements. As a further incentive, the participant is allowed to retain certain properietary rights to the results, particularly the proprietary information that would yield a competitive edge in marketing products based on the MPS flight data.

These legal and managerial mechanisms, in which the cost and risk of early commercial ventures can be shared, have made possible "constructive partnerships" between the government and the private sector. Agreements now in force, and those that have been publicly disclosed are:

- **Technical Exchange Agreement.** 1981 with Deere and Company, Moline, Illinois: effects of microgravity on solidification of metals.

- **Industrial Guest Investigators Agreement:** 1980 with TRW Equipment Division, Cleveland, Ohio: directional solidification in alloys.

- **Joint Endeavor Agreement.** 1980, with McDonnell Douglas: a Shuttle experiment with a continuous flow electrophoresis process, in which materials in solution are separated by subjecting them to an electrical field as they flow continuously through a chamber. Ortho Pharmaceutical Corporation has joined McDonnell Douglas as a partner in this business venture, to explore the production of pharmaceuticals in space.

- **Joint Endeavor Agreement.** 1982, with GTI Corporation: a multiple micro-experiment flight package to be developed for GTI by a third party will be flown by NASA. The package will be a furnace with multiple sub-enclosures designed to perform and control several separate experiments in solidification. GTI's role is to serve as a broker between NASA and potential investors, customers, inventors, and hardware manufacturers.

These agreements are attractive because they leave to NASA the tasks that it does well (namely those that involve detailed knowledge of reaching space and working in it) and to industry, the areas in which it has expertise.

For many experiments, the lure of free Shuttle flight is very attractive. However, as it stands, some industrial critics complain that the JEA is structured in such a way that a company must be able to commit a substantial investment to the Agreement in order to

enter into it. They must also be willing to do the marketing and financing as well as the initial hardware development. Small firms, universities, and research organizations generally do not have the capital necessary to undertake all of these tasks. However, if appropriate space were available at a relatively low cost, then a broad range of otherwise unaffordable research might be undertaken. By allowing different organizations to take on different tasks, each committing itself to only part of the total investment, more might be able to enter the field. NASA, in turn, might be able to strengthen an already powerful tool. Such a disaggregation of the responsibilities of MPS research has already begun to take place in the JEA with the GTI cooperation. GTI's willingness to accept the financial responsibility for one aspect of the commercialization process (in this instance, providing a valuable research tool), can provide the incentive for other firms to invest research dollars in this area.

Extending the Joint Endeavor Agreement

The concept of the Joint Endeavor Agreement has so far been applied only to materials processing. Can it be extended to other profit-making activities in space? Two arrangements seem worth exploring:

- **Shuttle experiments.** Under the right conditions, the offer of free transportation for testing an experimental process or a piece of equipment would be a powerful incentive in other technologies as well. It could be used to test new equipment in space: sensors, robot devices, cameras. A major drawback of the JEA is that the Agreement requires considerable legal, administrative and technical resources to put it into effect by both NASA and the interested private firm. Thus the JEA is worth working out for major investments, but not for small ones. For the smaller experiments, a formal agreement is much too expensive. If NASA were to make a

small percentage of the Shuttle payload available for industrial experimentation at a reduced charge, more companies could become involved for relatively little investment. NASA's getaway special experimental packages already satisfies part of this need. However, each of the experiments must be completely self-contained and have no access to power from the Shuttle, nor can they be exposed to space. Thus, only a limited range of experiments can be carried out under these circumstances. In order to test sensors or anyother equipment that needs access to space or onboard power sources, a wider range of experimental possibilities necessary.

o **Public Service.** Because of the maturity of satellite communications technology, and the low earth orbit of the Shuttle, it is unlikely that it would be helpful to test many communications devices on the Shuttle. However, it should be possible to construct suitable arrangements for using a specified percentage of a new communication satellite's transponders for public service in return for tranporting it to space. Operations and maintenance costs for the transponders could be borne by the public users. This arrangement would have the advantage of reducing the risk for the corporation, and providing a long-term service for the public good. If the experiment worked, all would benefit. If it failed, each would have lost a portion of the investment and the service. The corporation that designed and flew the satellite would earn a viable return from the balance of the satellite. In effect, it would be paying for the free launch service over a very long period. In the past, NASA has used the opportunity provided by satellite system demonstration projects to provide similar public services. The foreign and domestic experiments with public broadcasting and voice transmission on the Applications Technology Satellite Series are excellent examples of this practice. Such experiments have served the nation well by demonstrating the utility of satellites for providing health care and educational services, disaster assessment and relief, and emergency medical services to remote locations. An arrangement with private industry to provide similar public services in return for the launch of a new satellite would provide new and expanded public service opportunities and could also eventually provide new markets for the communications industry.

Table I.

Space Activities of the U.S. Government

HISTORICAL BUDGET SUMMARY — BUDGET AUTHORITY

(in millions of dollars)

Fiscal Year	NASA		Defense	Energy	Commerce	Interior	Agriculture	NSF	Total Space
	Total	Space[a]							
1959	330.9	260.9	489.5	34.3	...	...	...	...	784.7
1960	523.6	461.5	560.9	45.3	...	...	...	0.1	1065.8
1961	964.0	926.0	815.9	67.7	...	...	...	.6	1808.2
1962	1824.9	1796.8	1298.2	147.8	50.7	...	...	1.5	3294.8
1963	5675.0	3626.0	1549.9	213.9	43.2	...	...	1.5	5434.5
1964	5099.7	5016.3	1599.3	210.0	2.8	...	...	3.0	6831.4
1965	5249.7	5137.6	1575.9	228.6	12.2	...	...	3.2	6955.5
1966	5174.9	5064.5	1688.8	186.8	26.5	...	...	3.2	6969.8
1967	4965.6	4850.2	1665.6	183.6	29.5	...	...	2.8	6709.5
1968	4587.3	4430.0	1921.8	145.1	28.1	0.2	0.5	3.2	6528.9
1969	3990.9	3822.0	2013.0	118.0	20.0	.2	.7	1.9	5975.8
1970	3745.8	3547.0	1678.4	102.8	8.0	1.1	.8	2.4	5340.5
1971	3311.2	3101.3	1512.3	94.8	27.4	1.9	.8	2.4	4740.9
1972	3506.6	3071.0	1407.0	55.2	31.3	5.8	1.6	2.8	4574.7
1973	3406.2	3099.2	1625.0	54.2	39.7	10.3	1.9	2.6	4824.9
1974	3036.9	2758.5	1766.0	41.7	60.2	9.0	3.1	1.8	4640.3
1975	3229.1	2915.3	1892.4	29.6	64.4	8.3	2.3	2.0	4914.5
1976	3550.3	3225.4	1985.3	23.3	71.5	10.4	3.6	2.4	5319.9
T.Q.[b]	981.8	849.2	460.4	4.6	22.2	2.6	.9	.6	1340.5
1977	3817.8	3440.2	2411.9	21.7	90.8	9.5	6.3	2.4	5982.8
1978	4060.1	3622.9	2728.8	34.4	102.8	9.7	7.7	2.4	6508.7
1979	4595.5	4030.4	3211.3	58.6	98.4	9.9	8.2	2.4	7419.2
1980	5240.2	4680.4	3848.4	39.6	92.6	11.7	13.7	2.4	8688.8
1981 Est.	5519.1	4997.2	4789.4	42.0	91.9	12.1	15.5	2.4	9950.5
1982 Est.	6118.3	5617.3	5916.3	38.0	126.3	12.6	17.2	2.0	11729.7

[a] Excludes amounts for air transportation (subfunction 402).

[b] T.Q. = Transitional Quarter.

SOURCE: Office of Management and Budget

Table 2

Factors Involved in Determining Economic Viability

1) Potential size and value of the market
2) Certainty of the market (including price elasticity)
3) Length of time from committment of capital resources until the start of payback and projected break-even.
4) The expected rate of return on investments
5) The costs of money, materials and labor, and their stability over time.
6) Competitive market structure for the service or product

Table 3

BARRIERS TO INVESTMENT IN SPACE

Technological

Uncertain technology

Systems tend to be complex

Uncertainty of space environment*

Economic

High cost to reach space*

Market risks uncertain

High cost of technology development

Regulatory/policy

Government controls access*

Status of civilian space program uncertain*

* Unique to space environment

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RECOMMENDATIONS

of the

National Conference of State Legislatures'

Natural Resource Information Systems Project

and the

National Governors' Association/Council of State Planning Agencies'

Earth Resources Data Council

on

NASA Landsat Technology Transfer Activities

April 30, 1981

NRIS Task Force members

Representative Thomas Anderson, Chairman (MI)
Robert E. Hansen, Vice-chairman (MN)

Senator Earl Christensen (WY)
Representative Monroe Flinn (IL)
Senator Fred A. Kerr (KS)
Representative Dale Locker (OH)
Senator John McCune (OK)
Senator Rolland Redlin (ND)
Senator Jerome Van Sistine (WI)
Representative A.J. "Mick" Spano (CO)
Delegate Judith Toth (MD)
Representative Bill Wilkerson (MS)

Earth Resources Data Council members

Bruce Rado, Chairman (GA)
David Ferguson, Vice-Chairman (TX)

Timothy Hays (CA)
Bernard Hoyer (IA)
Dennis Malloy (VT)
Robert Mills (NJ)
Jay Moor (AK)
Edwin Thomas (MD)
Donald Yaeger (MN)

Ex-Officio Members:
Paul Tessar (NCSL)
Perry Wigley (Representative of NGA Chairman)

TECHNOLOGY TRANSFER

The States understand that technology transfer activities may eventually fall within the realm of the private sector. The idea that the private sector will be providing this type of service to the states is acceptable for the mid- to long term future. However, we must recognize that the private sector is not ready or willing to take up this role immediately. In the short term, the federal government will need to continue providing some level of services to state and local governments, and to plan for an orderly phasing out of technology transfer programs while at the same time allowing for a phasing in of private sector services.

The proposed elimination of NASA Landsat Technology Transfer activities would have a severe impact on the States. These programs (Regional Applications and User Requirements and Awareness Program, in particular) have enabled the States to apply the findings and techniques of NASA to a wide range of significant state resource problems. Given the $1 billion the federal government has invested in Landsat technology, the cost/benefit ratios are definitely in favor of continuing the program.

* * * * * * * * * *

The States recommend that the Congress and the Administration include $9 million in the NASA Technology Transfer Program budget, half of which should be specifically earmarked to support the Regional Applications Program and the User Requirements and Awareness Program.